Do Superstitious Traders Lose Money?

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Abstract

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JEL Classifications: D14, G02, G14, G15

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Abstract

Do superstitious traders lose money? We answer this question in the context of trading in the Taiwan Futures Exchange, where we exploit the Chinese superstition that the number "8" is lucky and the number "4" is unlucky. We find that individual investors, but not institutional investors, submit disproportionately more limit orders at "8" than at "4." This imbalance, defined as "superstition index" for each investor, is positively correlated with trading losses. Superstitious investors lose money mainly because of their bad market timing and stale orders. Nevertheless, the reliance on number superstition for limit order submissions does decrease with trading experience.

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Superstition, which is defined as a belief that is not based on reason, has been a part of the human condition since humans began.[1] Michael Jordan, arguably the greatest basketball player of all time, wore his University of North Carolina shorts under his uniform every time he led the Chicago Bulls to their six NBA championships.[2] The European governing body of Formula 1 auto racing, which is based in Paris and Geneva, bans the number "13" in its entry list for cars.[3] India's Independence Day falls a day after Pakistan's because astrologers in India insisted that August 14, 1947, was an inauspicious day to become independent.[4] The Games of the XXIX Summer Olympics opened in Beijing on August 8, 2008, at 8:08 p.m. because the number "8" is a lucky number in Chinese culture. In contrast, Chinese culture considers the number "4" to be unlucky. For instance, some buildings in China have no fourth floor (Kramer and Block, 2008), and there is an unwritten rule in the Taiwan Navy that the digits of a naval vessel's number should not add up to four (Tsang, 2004).

It is surprising, considering how pervasive superstition is globally, that there is no academic research, as far as we know, on the effect of superstition on individual trading decisions and investment performance. This paper is one such piece of research that aims to add to the emerging literature on the behavior of retail investors. Specifically, we investigate whether some investors carry their superstitious beliefs in numbers over to their trading, how this type of superstitious trading behavior affects their investment performance, and, lastly, whether learning by trading helps investors alleviate their reliance on their number superstition.

We answer these questions by examining limit order submissions in the Taiwan Futures Exchange (TAIFEX). In Mandarin, the official language of Taiwan, the pronunciation of the number "4" sounds like "death" and is regarded as inauspicious. On the contrary, the number "8" is considered auspicious as its pronunciation sounds like "good fortune." If Mandarin-speaking investors prefer the

[1] Miller and Taylor (1995) and Kramer and Block (2008) provide some theoretical underpinnings to explain the effect of superstitious beliefs on decision making.
[2] http://www.mensfitness.com/life/sports/10-most-superstitious-athletes
[3] https://joesaward.wordpress.com/2009/12/01/why-there-is-no-number-13-in-formula-1/
[4] http://mukto-mona.net/Articles/mehul/superstition_india271205.htm

number "8" over the number "4," we might observe disproportionately more limit orders submitted at prices ending with the number "8" and disproportionately fewer limit orders submitted at prices ending with the number "4."[5]

Taking advantage of the account-level trades and quotes records of index futures in TAIFEX, we show that individual investors are indeed affected by this number superstition when submitting limit orders. The submission ratio at "8," calculated as the limit orders submitted at prices ending with "8" over all submitted limit orders, is 0.098.[6] This ratio is significantly higher than 0.063, the submission ratio at prices ending with "4." In contrast, the difference between the submission ratios at these two numbers is not significant for domestic institutional investors nor for Qualified Foreign Institutional Investors (QFIIs). In particular, for domestic institutional investors, the submission ratio at "8" is 0.103, while the submission ratio at "4" is 0.100. The submission ratios at "8" and "4" for QFIIs are 0.097 and 0.094, respectively. These results indicate that individual investors use heuristics based on number superstition when making investment decisions, whereas institutional investors, domestic or foreign, do not.

Next, we investigate the association between investors' number superstition and their investment performance. To empirically test this association, we calculate the limit order submission ratios at prices ending at 0, 1, 2, …9 as the number of limit orders submitted at that price point scaled by the total number of limit orders submitted at all price points. We then construct a superstition index for each

[5] We focus on the last digit because the effect of superstitious beliefs is more likely to be present in this digit. In most trading days within our sample period, only the last two digits of the four-digit Taiwan futures index move, the last digit (right-most digit) moving the most. Therefore, it is reasonable to assume that investors mostly concentrate on the last digit when making their trading decisions. In this sense, our paper is distinct from the price barrier literature, such as Ley and Varian (1994), who show that prices behave differently when they approach round numbers like 100 and 1000. They focus on the left-most digit while we focus on the right-most digit. Meanwhile, unlike the left-most digit, there is no evidence that the right-most digit of prices follows Benford's Law (Benford, 1938, and Ley, 1996). In our case, if investors are not superstitious, we would observe a uniform distribution of the last digit of limit order prices.

[6] We find that the limit orders submission ratios at prices ending with "0" and "5" of individual investors are 0.249 and 0.148, respectively. This is consistent with the notion that individual investors' limit order tend to cluster at round numbers (Kuo, Lin, and Zhao, 2015).

investor by calculating the difference between his limit order submission ratios at prices ending at "8" and at "4."[7] The higher the superstition index, the more superstitious an investor is.

After sorting individual investors into five groups according to their superstition indices in the current year, we find that individual investors with a higher degree of number superstition have significantly lower intraday, 1-day, and 5-day mark-to-market index returns of their executed limit orders in the subsequent year. The individuals within the top-quintile of the superstition index underperform their counterparts within the bottom-quintile of the superstition index by 1.7 basis points within a trading day. The underperformance deteriorates to 2.4 (6.3) basis points one (five) day(s) after the limit order executions. In addition, we also find underperformance of superstitious individual investors for their market orders and round-trip trades. Specifically, the underperformance of intraday market orders is 1.3 basis points, which is similar in magnitude as the underperformance of the intraday limit order returns.

The negative association between superstition index and subsequent investment performance remains significant after controlling for several factors that are known to be related to investment performance. These factors include the wealth (proxied by the average order size), cognitive limitation (proxied by the round-number limit order submission ratio used in Kuo, Lin, and Zhao, 2015), experience (proxied by the number of limit orders submitted in the previous year), the disposition effect, and the past performance. We also find similar results based on a two-stage regression. In particular, we first regress the superstition index on the concurrent control variables to extract the residual superstition index. We then regress the investment performance on the residual superstition index which, by construction, is orthogonal to the control variables. Both findings indicate that the number superstition captures a distinct aspect of investors' trading skill that is negatively related to their investment performance.

We then perform two sets of placebo tests to check the robustness of the negative link between superstition and trading performance. First, since we find that limit order submissions of institutional investors are not affected by lucky/unlucky numbers, we should not find the superstition index to be

[7] The superstition index is calculated using all submitted limit orders, while the investment performance is calculated only using the executed ones.

associated with investment performance for these investors. Our results are in line with this intuition. Second, we construct a pseudo superstition index using the difference between submission ratios at "7" and "3." The numbers "7" and "3" are viewed as neither lucky nor unlucky in Chinese culture. We find that the pseudo superstition index is not correlated with investment performance, which lends further support to our main findings.[8]

We next explore why superstitious investors lose money. We find that superstitious individual investors have bad market timing as they buy less (more), compared with their non-superstitious counterparts, on trading days with high (low) market returns. This could be partly driven by the fact that their limit orders become stale in the absence of active monitoring after submission, and other traders take advantage of this by hitting their limit orders with a buy (sell) order immediately after good (bad) news. Our results indicate that the limit orders submitted by superstitious individual investors do have longer time-to-execution and time-to-cancellation for both buy and sell orders. We go on to show that institutional investors, both domestic and foreign, make money from the most superstitious traders.

Finally, we examine whether investor learning could mitigate the reliance on the number superstition for submitting limit orders. Seru, Shumway, and Stoffman (2010) find that some individual investors may become better at trading with experience. In our context, investors might become less affected by the superstitious number heuristics when they learn from past trading experience. To test this learning-by-trading hypothesis, we regress the difference of superstition index between two consecutive years on the number of limit orders submitted in the previous year. We use the difference in superstition index to control for the unobserved invariant investor characteristics. Our result shows that past trading frequency helps to reduce individual investors' propensity to submit superstitious limit orders. A one-standard-deviation (51 limit orders) increase in the number of limit orders submitted in the previous year

[8] We also consider two more pseudo superstition indices, the differences between submission ratios at "7" and "2" and those at "2" and "3." We do not find a significant association between these two pseudo superstition indices and investment performance either. These results are not tabulated but, like all other successive untabulated results, are available from the authors on request.

leads to a 0.74% more reduction of the superstition index in the current year. We further find that, though trading experience reduces superstition, this learning effect diminishes over time.

Alternatively, investors could learn in a naïve and reinforced way from their past performance. Chiang, Hirshleifer, Qian, and Sherman (2011) show that high returns in previous IPO auctions increase the likelihood of participating in future auctions, and both bidders' returns and their auction selection abilities deteriorate afterwards. However, we do not find supportive evidence for this reinforcement learning, as individual investors do not submit more limit orders at "8" when they observe higher returns of orders submitted at these lucky prices.

Our paper contributes to the literature on retail investor behavior, the field that deals with the psychological biases that affect individual trading decisions (biases like overconfidence or disposition effect) and the consequences of these biases on investment performance.[9] Specifically, we explore one particular type of heuristics that some investors have when making trading decisions: reference points based on number superstition. Since the seminal work by Tversky and Kahneman (1974), there have been many studies exploring how people rely on reference points when making choices under uncertainty. For example, 52-week high stock prices have been shown to influence financial decisions among various market participants.[10] A number of studies find that round number prices serve as reference points in financial decision making as well.[11] Although there are few studies on lucky and unlucky numbers as reference points, we provide the first attempt to show that some retail investors use lucky and unlucky

[9] Barber and Odean (2013) provide an excellent survey of this field.

[10] The following have been influenced: corporate managers (Baker, Pan, and Wurgler, 2012), employees (Heath, Huddart, and Lang, 1999), options traders (Poteshman and Serbin, 2003; Driessen, Lin, and Van Hemert, 2013), stock traders (George and Hwang, 2004; Li and Yu, 2012), and analysts (Birru, 2015; Li, Lin, and Lin, 2015).

[11] See, for example, Neiderhoffer (1965, 1966); Ball, Torous, and Tschoegl (1985); Harris (1991); Curcio and Goodhart (1991); Donaldson and Kim (1993); Christie and Schultz (1994); Christie, Harris, and Schultz (1994); Ley and Varian (1994); Gwilym, Clare, and Thomas (1998a, 1998b); Booth, Kallunki, Lin, and Martikainen (2000); Palmon, Smith, and Sopranzetti (2004); Sonnemans (2005); and Bhattacharya, Holden and Jacobsen (2012).

numbers to make their trading decisions, and their trading profits are related to the reliance on this heuristic.[12]

The fact that superstitious individuals exist in the world may be obvious. However, it is not clear that they carry their superstition to trade important assets like a stock index futures. Further, as heuristics are often efficient thumb rules that govern decisions under uncertainty, it is not clear that all heuristics used in financial decision-making lead to losses. Superstitious investors may not lose money if their superstitious beliefs in numbers, though interesting in its own right, is irrelevant to their trading prowess. Thus, finding out why they lose money – bad market timing and stale orders – sheds more light on our understanding of the retail investor behavior.

Lastly, our paper also adds to the household finance literature, a literature Campbell (2006) succinctly motivates in his AFA presidential address: "The welfare benefits of financial markets depend in large part on how effectively households use these markets." Our results indicate that some retail investors use financial markets unwisely, and so there may be room for financial education to improve their welfare as we show that learning mitigates the reliance of retail investors on number superstition.

I. Hypotheses Development from the Literature

A. Limit Orders Submitted at Prices Ending with Lucky and Unlucky Numbers

The psychology literature documents that superstitious beliefs affect individuals' optimism (e.g., Darke and Freedman, 1997). Superstitious beliefs also affect the willingness to take financial risks.[13] Recent studies on real estate prices show that housing prices are inflated when the floor number or the

[12] For example, Kolb and Rodriguez (1987) find that during the period from 1962 to 1985, the mean CRSP index return for Friday the Thirteenth is significantly lower than that for other Fridays. However, Dyl and Maberly (1988) do not find the same result according to S&P index return data from 1940 to 1987.

[13] Using cognitive priming experiments, Jiang, Cho, and Adaval (2009) find that Asian individuals, who are exposed to lucky numbers, give higher estimates of their chances of winning a lottery, are more willing to participate in a lottery or a risky promotional game, and express greater willingness to make risky financial investments.

number in the address is a lucky one.[14] In financial markets, there is limited evidence that numerical superstitious beliefs matter.[15] Hirshleifer, Jian, and Zhang (2016) find that newly listed Chinese firms are more likely to have lucky numbers in their listing codes. The firms with lucky listing codes are traded at a premium and experience inferior post-IPO abnormal returns. Brown, Chua, and Mitchell (2002) and Brown and Mitchell (2008) show that the daily opening and closing prices cluster at the number "8" in Asian Pacific and Chinese stock markets.

IPO listing codes and transaction prices do not directly reflect the number preference of individual investors, as investors do not directly control listing codes or transaction prices. In contrast, individual investors directly choose the prices for their limit orders. The question is which digit of the four-digit TAIFEX index investors are most likely to focus on when they submit their limit orders. Although the price of index futures in TAIFEX ranges from 4,011 to 9,934 during our sample period, the average daily standard deviation and daily price range are only around 26 and 87 index points, respectively. On most trading days within our sample period, only the last two digits of the four-digit index fluctuate. Furthermore, since a tick size is one index point, and an investor can only observe the five best asks and bids in the limit order book, the effect of superstitious beliefs is most likely to appear in the last digit of the four-digit index.[16]

If investors are not affected by their superstitious beliefs, the last digit of limit order prices should be uniformly distributed. If, on the contrary, individual investors take lucky/unlucky numbers into account when submitting limit orders, it would lead to a disproportionately large (small) volume of limit orders submitted at prices ending with lucky (unlucky) numbers. This gives us our first hypothesis:

[14] See, for example, Agarwal, He, Liu, Png, Sing, and Wong (2014); Shum, Sun, and Ye (2014); and Fortin, Hill, and Huang (2014).

[15] Dichev and Janes (2003), Yuan, Zheng, and Zhu (2006), and Lepori (2009) show that the occurrence of negative superstitious events (i.e. eclipses) is associated with lower trading volumes and lower stock returns.

[16] Take the limit order book at 13:45 on September 12, 2014, for example. The best five bid prices are 9244, 9243, 9242, 9241, and 9240, while the best five ask prices are 9245, 9246, 9247, 9248, and 9249, respectively. The only difference among these best five bids and five asks is in the last digit.

Hypothesis 1: Individual investors submit a disproportionately large volume of limit orders at prices ending with "8" and submit a disproportionately small volume of limit orders at prices ending at "4." Moreover, institutional investors, particularly QFII, are not subject to this number superstition.

Domestic institutional investors may not be affected by number superstition if their order submissions hinge on their professional analyses. For the foreign institutional investors, as the number superstition originates from the Mandarin language, this type of superstition should be even more irrelevant to their financial decision making.[17] We thus expect limit order submissions to be uniformly distributed in the last digit for institutional investors.

B. *Superstition and Investment Performance*

There exist two intimately related causes why the superstition index might be negatively related to the subsequent investment performance of an individual investor. First, superstition might reflect an investor's overall trading skills, and this leads to a negative correlation between superstition index and investment performance. This inferior trading skill could be due to lower abilities in information gathering and information processing. As the trading skill has been linked to other investor characteristics like wealth, experience, cognitive ability, and other behavioral biases like the disposition effect, it is important to show that the negative relation between our superstition index and investment performance remains significant even after controlling for these investor characteristics.

For example, Geng, Li, Subrahmanyam, and Yu (2014) find that the wealthy investors in China beat the performance of the market portfolio by a large margin. Seru, Shumway, and Stoffman (2010) show evidence that trading experience helps to improve investment decisions. Cognitive ability, proxied by an investor's IQ, is found to be associated with his wealth level, stock market participation, investment performance, and mutual fund choice (Grinblatt, Keloharju, and Linnainmaa, 2011, 2012; and Grinblatt, Ikäheimo, Keloharju, and Knüpfer, 2016). Similarly, Kuo, Lin, and Zhao (2015) employ the proportion of

[17] Institutional investors from China, who may be subject to the same numerical superstition, did not trade in the Taiwanese financial markets during our sample period.

limit orders submitted at round number prices as a proxy for cognitive limitation and show a negative correlation between cognitive limitation and investment performance. Further, Odean (1998) finds that investors who are reluctant to realize their losses – the disposition effect – have lower subsequent returns. In our multivariate regressions, we incorporate these known characteristics as control variables. Our result is robust to controlling for this set of proxies for poor trading skills.

Second, even when an investor has average trading skills, his number preference originating from superstition might result in a suboptimal submission strategy of limit orders, which also leads to a negative relation between our superstition index and limit order performance. For example, when it is optimal to submit a limit order ending at "7" or "9," a superstitious investor might choose to submit at "8," which results in a lower performance at "8." For another example, when it is optimal to submit at "4," a superstitious investor might submit at "3," "5," or any other number, which also leads to the underperformance for limit orders whose prices end with numbers other than "4."

We thus propose our second hypothesis as follows:

Hypothesis 2: An investor's superstition level is negatively associated with his subsequent investment performance.

To test our second hypothesis, we calculate a superstition index for each investor in the following way. We first calculate the limit order submission ratios at prices ending at 0, 1, 2, …9 as the number of limit orders submitted at that price point scaled by the total number of limit orders submitted at all price points. A superstition index is then constructed for each investor by calculating the difference between his limit order submission ratios at prices ending at "8" and at "4." The higher the index, the higher the number superstition of an investor. In the empirical section, we do find that superstitious investors underperform and exhibit some suboptimal limit order submission strategies like bad market timing or stale limit orders. They also lose money at all price points to institutional investors.

C. Investor Learning

The investor learning literature has shown that past trading experience has an impact on investment decisions. One line of literature focuses on learning by trading. Feng and Seasholes (2005) and Dhar and Zhu (2006) both find that investors' trading experience, measured as trading frequency, mitigates the reluctance to realize losses. Seru, Shumway, and Stoffman (2010) show that some individual investors become better at trading when they become more experienced, while others stop trading after realizing that they have poor trading skills. Their findings show a positive influence of investor learning on future investment performance.

Another line of investor learning literature argues that investors could learn in a naïve and overoptimistic way. For example, Choi, Laibson, Madrian, and Metrick (2009) find that individual investors over-extrapolate from their personal experience when making savings decisions in their 401(K) accounts. Chiang, Hirshleifer, Qian, and Sherman (2011) document that when a bidder had high returns in previous IPO auctions, he is more likely to participate in future auctions. Nevertheless, the returns and the auction selection ability deteriorate with his previous IPO auction returns. Their findings show that reinforcement learning based on past investment performance could negatively affect future performance.

It is important to note that the two lines of literature use different measures for learning; the former uses past trading experience (frequency) and the latter uses past returns. In our context, if investors learn from trading experience, we should observe that they become less superstitious when more trading experience is accumulated. If investors learn in a naïve way, they may submit more orders at "8" when their limit order returns at "8" are high, and less orders at "4" when limit order returns at "4" are low. We thus propose the following hypotheses:

Hypothesis 3.A (Learning by Trading): The change in an investor's superstition index between two years is negatively associated with the investor's trading frequency in the previous year.

Hypothesis 3.B (Reinforcement Learning): The change in an investor's superstition index between two years is positively (negatively) associated with investor's performance of limit orders submitted at "8" ("4").

II. Data Description

A. The Taiwan Futures Exchange

TAIFEX employs an Electronic Trading System (ETS) to process orders submitted by market participants from 8:45 a.m. to 1:45 p.m. The two major types of product traded in TAIFEX include the Taiwan Stock Exchange Index Futures (hereafter TXF) and the Mini-Taiwan Stock Exchange Index Futures (hereafter MXF). The TXF is based on all listed stocks on the Taiwan Stock Exchange and the MXF is a mini version of the TXF with a quarter of the margin and payoff for the TXF. The tick size of both contracts is one index point. One index point increase in the transaction price yields a profit of 200 (50) New Taiwanese Dollar (TWD) for one TXF (MXF) contract.[18] Both types of index futures have five maturity months: the spot month, the next calendar month, and the next three quarterly months. Each type of index futures with a certain maturity month is traded as one unique product in TAIFEX.[19]

B. Submitted and Executed Limit Orders

We use all the limit order submission and execution records in TAIFEX during the period from January 2003 to September 2008. The data contain detailed information about investor account identity and investor type (individual investors, domestic proprietary investors, or Qualified Foreign Institutional Investors (QFIIs)). We are thus able to examine the superstitious behavior of different investor types.

Panel A of Table I shows that there are about 108 million limit orders submitted by market participants during the sample period. Among these orders, 61.87% are from individual investors, 34.17% from domestic proprietary investors, and 3.96% from QFIIs. Panel B of Table I shows that there are about

[18] One US Dollar is around 30 TWD during our sample period.
[19] More institutional details for TAIFEX can be found in Liu, Tsai, Wang, and Zhu (2010), Li, Lin, Cheng, and Lai (2013), Kuo and Lin (2013), and Kuo, Lin, and Zhao (2015).

143 million limit order contracts transacted during our sample period.[20] Individual investors account for 73.20% of the transaction volume, while domestic institutional investors and QFIIs together account for the rest. Notice that one very important feature in TAIFEX is that individual investors, instead of institutional investors, are the major market participants. This market, therefore, provides us with an ideal environment to study the number superstition in trading among individual investors. Its second advantage is that index futures, unlike stocks, is a single product with a single large and liquid market, and so we do not have to control for various cross-sectional firm-specific stock characteristics.

(INSERT TABLE I HERE)

When investigating the link between number superstition and investment performance, we require that investors submit at least 10 limit orders in each of two consecutive years to generate a meaningful estimate of the superstition index.[21] After applying this screen, we obtained 125 million trades and 156,171 investor-year observations.

III. Limit Orders at Prices Ending with Lucky and Unlucky Numbers

A. Limit Order Submissions among Different Investor Types

To identify number superstition, we focus on the last digit of limit order prices. For example, if the limit order price is 6,508, we characterize the order as submitted at a price ending with the lucky number "8." Similarly, the limit order with a price of 6,504 is treated as an order submitted at a price ending with the unlucky number "4." The same logic is applied to other numbers in the last digit. We then calculate the limit order submission ratios at prices ending with a number "X" for the individual investors, domestic institutional investors, and QFIIs as follows:

$$SubRatio_X = \frac{Number\ of\ limit\ orders\ submitted\ at\ "X"}{Total\ number\ of\ submitted\ limit\ orders} \quad (1)$$

[20] Individual investors typically trade one or two contracts in one order, while institutional investors typically trade more contracts in one order. The overall execution ratio for submitted contracts is around 0.444.

[21] The same data filter is adopted in Kuo, Lin, and Zhao (2015).

The submission ratio measures the proportion of limit orders submitted at prices ending with "X" (X is an integer ranging from 0 to 9). Theoretically, if investors trade index futures based on information or hedging needs, their limit orders should be equally likely to be submitted at prices ending with any integer ranging from 0 to 9. So this ratio should be 0.1 for each of the 10 Xs. However, if investors are affected by the superstition heuristic, they would submit disproportionately more limit orders at prices ending with "8" (the lucky prices) and fewer limit orders at prices ending with "4" (the unlucky prices).[22]

Figure 1 shows the limit order submission ratio for each of the 10 last digits separately for individual investors, domestic institutions, and QFIIs. Figure 1.A shows that individual investors indeed submit more limit orders at "8" than those at "4." The submission ratio is 0.098 at "8," which is much higher than the 0.063 at "4." The statistical significance of the difference in these two submission ratios will be presented in the regression analysis in the next sub-section. Figure 1.A also shows that individual investors tend to submit more limit orders at round numbers "0" and "5." This is consistent with the limit order clustering at round number prices documented in Kuo, Lin, and Zhao (2015). Figure 1.B shows a fairly uniform distribution of submission ratio for domestic institutions. In particular, the submission ratio at "8" is 0.103, while the submission ratio at "4" is 0.100. A similarly flat pattern for QFIIs is observed in Figure 1.C, where the submission ratios at "8" and "4" are 0.097 and 0.094, respectively.

B. Multivariate Regression Analyses

In this sub-section, we test the statistical significance of the number superstition through multivariate regression analyses. For each limit order, we are able to determine if it is submitted by an

[22] In addition to the superstition for price, we also consider the superstition for date. We examine the proportion of limit orders submitted on each date of the month. The logic is that if investors prefer the number 8 over 4, they might submit more limit orders on the 8th of the month relative to the 4th of the month. However, we do not find supportive evidence for date superstition. Figure A1.A in the Appendix shows that the submission ratio on the 8th of the month is not significantly higher than that on the 4th of the month for individual investors. The same is true for domestic institutions (Figure A1.B in the Appendix) and QFII (Figure A1.C in the Appendix).

individual investor, a domestic institution, or a QFII, and if it is to trade the MXF or the TXF. We run the following regression:

$$
\begin{aligned}
SubRatio_X - 0.1 &= \alpha + \beta_1 D_8 + \beta_2 D_4 + \beta_3 D_0 + \beta_4 D_5 + (\beta_5 D_8 + \beta_6 D_4 + \beta_7 D_0 + \beta_8 D_5) \times D_{indv} \\
&+ (\beta_9 D_8 + \beta_{10} D_4 + \beta_{11} D_0 + \beta_{12} D_5) \times D_{QFII} + (\beta_{13} D_8 + \beta_{14} D_4 + \beta_{15} D_0 + \beta_{16} D_5) \\
&\times D_{MXF} + (\beta_{17} D_8 + \beta_{18} D_4 + \beta_{19} D_0 + \beta_{20} D_5) \times D_{indv} \times D_{MXF} \\
&+ (\beta_{21} D_8 + \beta_{22} D_4 \quad + \beta_{23} D_0 + \beta_{24} D_5) \times D_{QFII} \times D_{MXF} + \beta_{25} D_{indv} + \beta_{26} D_{QFII} \\
&+ \beta_{27} D_{MXF} + \varepsilon_X \qquad (2)
\end{aligned}
$$

The dependent variable is the deviation of the actual submission ratio at prices ending with "X" from its theoretical value, 0.1, under the assumption that the last digit of the prices of submitted limit orders follows a uniform distribution. In each year, $SubRatio_X$ is calculated separately for individual investors, domestic institutions, and QFIIs, and for MXF and TXF orders. D_8, D_4, D_0, and D_5 are dummy variables for X=8, 4, 0, and 5, respectively. Controlling for the round numbers, 0 and 5, facilitates removing the round-number effect. D_{indv} and D_{QFII} are indicators for individual and QFII investors, respectively. D_{MXF} equals 1 if the order is to trade MXF, and 0 otherwise.

β_1, β_5, and β_9 measure the extent to which submission ratio is abnormal at prices ending at "8" for domestic institutions, individual investors, and QFIIs, respectively. Here "abnormal" means that it is different from the mean submission ratio at the six other price points, "1", "2", "3", "6", "7" and "9". Similarly, β_2, β_6, and β_{10} measure whether or not the submission ratio is abnormal at prices ending at "4" among these three groups, respectively.

Model 2 of Table II provides supportive evidence that individual investors tend to submit more limit orders at "8" than at "4". The proportion of limit orders submitted at "8" is 0.020 higher than the proportion of limit orders submitted at prices ending with a number other than "4," "0," and "5." The submission ratios at "4" is 0.013 lower than the proportion of limit orders submitted at prices ending with a number other than "8," "0," and "5". The F-test shows that the difference between β_5 and β_6 is

significant.[23] For institutional investors, the submission ratios are not significantly higher or lower at "8" and "4." Model 5 of Table II shows that when we incorporate the triple-interaction terms, the insignificant coefficient β_{17} (-0.001) suggests that individual investors do not have a preference for the lucky prices ending at "8" beliefs when submitting both MXF and TXF orders. In contrast, the significantly negative coefficient β_{18} (-0.012) suggests that individual investors seem affected by their superstitious beliefs to avoid the unlucky prices ending at "4" when submitting both MXF than TXF orders.

(INSERT TABLE II HERE)

C. Submissions of Buy and Sell Orders

To take a closer look at the limit order submissions at the lucky and unlucky numbers, we report the submission ratios at the last one digit separately for buy and sell orders. This allows us to investigate if the number superstition varies among buy and sell limit orders. Figures A2 and A3 in the Appendix show that individual investors indeed submit more orders at "8" than at "4" both when they buy and when they sell. Similar to the previous results, such pattern is not evident for institutional investors.

In summary, individual investors exhibit a significant and economically meaningful superstition heuristic in lucky and unlucky numbers when submitting limit orders. This result is robust to the type of limit order, namely, buy orders versus sell orders. On the other hand, institutional investors, domestic or foreign, do not exhibit statistically discernible patterns in number superstition. Overall, these results are supportive of Hypothesis 1.

IV. Superstition and Investment Performance

In this section, we construct an investor-level superstition index to measure the extent to which an investor's number superstition is revealed by his limit order submission. We then examine the association between the superstition index and investment performance.

[23] We also perform an F-test to show that the difference between ($\beta_1 + \beta_5$) and ($\beta_2 + \beta_6$) is significant. For brevity, however, only differences between the coefficients of interaction terms are reported in Table II.

A. The Superstition Index

In each year t, we calculate the superstition index for each investor i as the following:

$$SI_{i,t} = \frac{Number\ of\ limit\ orders\ submitted\ at\ "8" - Number\ of\ limit\ orders\ submitted\ at\ "4"}{Total\ number\ of\ limit\ orders\ submitted\ by\ investor\ i} \quad (3)$$

To ensure a meaningful calculation of the superstition index, we require that an investor submit at least 10 limit orders in each of two consecutive years.[24] Table AI in the Appendix presents the descriptive statistics of the superstition index. Panel A of Table AI shows that individual investors exhibit the highest degree of number superstition, with the mean and median being significantly higher than zero. Besides, the mean and median of superstition index appear to be persistent as well. In particular, the mean superstition index of individual investors slightly increases from 0.0365 in 2003 to 0.0493 in 2008. Moreover, the variation is large among these investors, with a high standard deviation around 0.091 in 2008. Panel B of Table A1 shows that domestic institutional investors seem to exhibit some degree of numerical superstition in general, while Panel C of Table A1 shows that QFIIs do not show much favor (disfavor) in submitting limit orders at prices ending with "8" ("4").

B. Superstition Index and Other Individual Investor Traits

We now report correlations between the superstition index and other individual investor traits documented in the literature. Table III shows that the superstition index persists over time. The correlation between the past year's superstition index and the current year's superstition index of an investor is 0.4205. This implies that number superstition is likely to be an investor's innate trait.

Table III also shows that the superstition index is negatively related to the average order size, which is our measure for investor's wealth level. The Taiwan Futures Exchange (TAIFEX) adopts a pre-

[24] We also tried to winsorize the superstition index at 1% level on both sides to check if our findings are driven by outliers. We find quite similar results before and after winsorization. Thus, in the main text, we simply report the results without any winsorization.

margin system where an investor is required to deposit an initial margin in his margin account before he can actually trade. The more contracts an investor purchases or sells, the more the margin he needs to deposit. Thus, we employ the average number of contracts per order, i.e. the order size, as a proxy for investor's wealth.[25] Our result indicates that wealthy investors tend to be less superstitious.

The correlation between superstition index and the limit order submission ratio at "0" and "5" is slightly negative, indicating that superstition index captures an investor's trading characteristic that is different from his preference for round numbers. Further, investors who exhibit more significant disposition effect tend to be more affected by their superstitious beliefs in numbers.

Collectively, the correlations in Table III show that superstition is related to other characteristics of investors that affect investment performance. The correlations, however, are not high in magnitude, implying that even though superstition is correlated with these investor characteristics, it is distinct from them. Thus, it is important to control for these investor traits when we perform the analysis on the relation between superstition and investment performance.

(INSERT TABLE III HERE)

C. Superstition Index and Investment Performance of Individual Investors—Quintile Analysis

We sort individual investors into quintiles by the superstition index in one year and look at their investment performance in the subsequent year. For the remainder of this paper, investors with higher (lower) superstition index are referred to as Q5 (Q1) investors. The performance metrics we use to

[25] For detailed margin requirement, please see the Internet Appendix in Kuo, Lin, and Zhao (2015) and the TAIFEX official website, http://www.taifex.com.tw/eng/eng2/TX.asp. We have also tried three other proxies for wealth. The first measure is the maximum order size, which is the largest order size that an investor submits within a year. The second and the third measures are the average open interest and the maximum open interest, respectively. Open interest is calculated as the maximum position that an investor is exposed to for one round-trip trade. The average open interest is the mean open interest of all round-trip trades in a year for an investor, while the maximum open interest is the maximum of an investor's open interest in all round trips in a year. Regression results of using these alternative wealth measures are quite similar, and are not tabulated in the paper. However, the results are available from the authors upon request.

measure investment performance include the limit order returns, market order returns, as well as the performance of the round-trip trades. As the average round-trip duration for index futures in TAIFEX is about two days, we look at the mark-to-market returns at the horizon of intraday, one day, and five days after transactions.

The first return metric we examine is the mark-to-market return of executed limit orders that initiate a long or short position on the same day. We calculate the intraday returns based on the difference between the daily closing price and the initiated limit order's price, divided by the latter. This calculation assumes that the initiated limit orders are covered (closed-out) at the closing price of the trading day. For each investor-year observation, we first calculate the average intraday returns, and then average them with equal weights for all of the observations in each quintile. We also calculate 1-day and 5-day mark-to-market returns with closing prices on days *t+1* and *t+5*, respectively.

Panel A of Table IV presents the mark-to-market returns of executed limit orders. We notice that the Q5 individual investors significantly underperform their Q1 counterparts by 1.7 basis points within a trading day. The inferior performance of the Q5 investors continues to deteriorate, and the performance gap widens to 2.4 (6.3) basis points for the 1-day (5-day) mark-to-market returns.

Panel A of Table IV also indicates that individual investors in all quintiles experience negative mark-to-market returns for their limit orders. This is consistent with the findings in Barber and Odean (2000) and Barber, Lee, Liu, and Odean (2009) that individual investors lose money on their investments.[26]

(INSERT TABLE IV HERE)

[26] The underperformance of superstitious individual investors, compared with their non-superstitious counterparts, exists not only for the limit orders submitted at prices ending with "8" but also for limit orders submitted at prices ending with other numbers. As discussed in Hypothesis 2, a preference of lucky number 8 and an avoidance of unlucky number 4 would distort the optimal limit order submission strategy for all numbers. This suboptimal limit order submission will ultimately lead to underperformance for limit orders ending at all numbers. We find this to be true. The results are reported in Tables AII, AIII, AIV, and Figure A4, all in the Appendix.

The mark-to-market intraday return of a market order is calculated in the same way, i.e., assuming that the initiated market order is covered at the closing price of the trading day. For each investor-year observation, we first calculate the average intraday returns in the current year, and then average them with equal weights among all of the observations in each quintile. Results for mark-to-market 1-day and 5-day returns are similarly calculated.

Panel B of Table IV shows that Q5 individual investors significantly underperform the Q1 individual investors by 1.3 basis points in their market orders within a trading day. The magnitude is similar to that of the intraday returns for limit orders. The underperformance deteriorates to 3.0 (5.6) basis points one day (five days) after the transactions.

We follow Jordan and Diltz (2003) and Feng and Seasholes (2005) to calculate the performance of round-trip trades. A round-trip trade is defined as a newly initiated position being covered. To adjust for the cross-sectional variation in the round-trip duration, and to facilitate the comparison with the mark-to-market returns of limit and market orders, we focus on the round-trip daily profit and daily index returns for the investors.

The round-trip profit is calculated as the number of index points earned or lost times 200 (50) TWD for the TXF (MXF) contracts. We calculate the round-trip index return as the profit divided by the average transaction price of all buy orders within a round-trip trade.[27] The round-trip daily profit (index return) is thus determined by dividing the average round-trip profit (index return) by the average round-trip duration.[28] Similar to the mark-to-market returns, all items are first calculated for each investor and then averaged with equal weights for investors in each quintile.

Panel C of Table IV shows that the Q5 individual investors significantly underperform Q1 individual investors by 1,199 TWD for daily profits. The realized underperformance in terms of round-

[27] A round-trip trade may contain several buys and sells before the position is back to zero.

[28] As round-trip trades sometimes have very short durations, the extremely short durations may lead to extremely large daily profits and daily index returns if we calculate the daily performance on a per round-trip basis. To mitigate this potential outlier issue, we first calculate the average round-trip duration and average profit for each investor, and then we calculate the investor's daily profit as average round-trip profit divided by average duration. Round-trip daily index returns are calculated in the same way.

trip daily index return is about 10.5 basis points per trading day. To have a better picture of the economic losses, we estimate the total realized profit for each investor in each quintile per year (by multiplying rows 1, 3, and 4 in Panel C of Table IV). The Q5 individual investors lose 105,341 TWD (roughly 3,200 USD) more than their Q1 counterparts per year during our sample period.[29] Such a loss is economically significant. It is also in line with our Hypothesis 2 that the investment performance of individual investors is negatively associated with their number superstition.

Panel C of Table IV also shows that the duration of losing round-trip trades is generally longer than that of winning ones for individual investors. This is consistent with the findings in Odean (1998) that individual investors are subject to the disposition effect when making their buying and selling decisions. Therefore, when we conduct the multivariate regression analysis, we control for the disposition effect to single out the effect of number superstition on investment performance.

D. Superstition Index and Investment Performance of All Investors —Multivariate Regression Analysis

We now perform the following multivariate cross-sectional regression:

$$Return_{i,t} = \alpha + \beta_1 SI_{i,t-1} + \beta_2 OrderSize_{i,t-1} + \beta_3 SubRatio_{0 \text{ and } 5,i,t-1} + \beta_4 Ln\left(N_{i,t-1}\right) + \beta_5 Disposition_{i,t-1} + \beta_6 Return_{i,t-1} + \varepsilon_{i,t}, \quad (4)$$

where $Return_{i,t}$ and $Return_{i,t-1}$ are the average mark-to-market returns or round-trip returns for investor *i* in years *t* and *t-1*. $SI_{i,t-1}$ is investor *i*'s superstition index in year *t-1*, calculated as the difference between limit order submission ratio at prices ending with "8" and that at prices ending with "4" in year *t-1*. The coefficient of particular interest is β_1, as it measures how the number superstition is associated with investment performance.

$OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year *t-1*, which serves as a proxy for the wealth level of an investor. $SubRatio_{0 \text{ and } 5,i,t-1}$ is investor *i*'s

[29] These incremental losses of Q5 individual investors are not driven by the excessive trading documented in Barber and Odean (2000) and Barber, Lee, Liu, and Odean (2009). In fact, though not tabulated, we find that Q5 investors trade less than their Q1 counterparts.

submission ratio at prices ending with "0" and "5" in year *t-1*. Kuo, Lin, and Zhao (2015) use the limit order submission ratio at round number prices to proxy for an investor's cognitive limitation. $Ln(N_{i,t-1})$ is the log of number of limit orders submitted by investor *i* in the previous year. $Disposition_{i,t-1}$ is the difference between the durations of losing and winning round-trip trades of investor *i* in year *t-1*, divided by their average. Controlling for these variables helps to single out the effect of superstition on investment performance. We also control for the past performance to account for the trading skill of the investor.

Table AV in the Appendix, which shows the results of the above multivariate regression, confirms the univariate results we documented in Table IV: superstitious investors lose money.

The first three columns of Panel A in Table AV show significantly negative coefficients of the superstition index for individual investors. The estimated β_1 for intraday limit order return equals -0.029, implying that a one-standard-deviation (0.084) increase in the superstition index results in a 0.24 basis points decrease in the mark-to-market intraday returns for individual investors, after controlling for investors' wealth, the round number submission ratio, trading experience, disposition effect, and past returns. Similar results hold for the mark-to-market 1-day and 5-day returns. We find a similar negative association between the superstition index and the market order performance for individual investors in the middle three columns of Panel A in Table AV. The significantly negative coefficient for 5-day return equals -0.198, implying that a one-standard-deviation (0.084) increase of the superstition index leads to a 1.66 basis points decrease in the mark-to-market 5-day return of market orders. The results are similar but less significant for the intraday and 1-day returns. The last two columns of Panel A present the multivariate regression results for the round-trip trades. The round-trip performance is negatively associated with the superstition index as well. A one-standard-deviation (0.084) increase in the superstition index leads to a lower (721 TWD) round-trip daily profit and a lower (5.84 basis points) daily index return.

Notice that the negative association between the superstition and investment performance in Panel A of Table AV remains significant even after controlling for wealth, cognitive limitation, trading experience, disposition effect, and past performance. This indicates that our superstition measure captures a distinct individual investor characteristic.[30] Furthermore, we find that $Disposition_{i,t-1}$ is negatively related to the investment performance of individual investors, suggesting that the more an investor exhibits the disposition effect, the lower are the returns of his investments. This is consistent with the findings in Odean (1998).

To summarize, both the main quintile analysis in Table IV and the subsequent regression exercises shown in Table AV in the Appendix provide evidence that the superstition index is negatively associated with the investment performance of individual investors. The more an investor is influenced by superstitious beliefs when deciding the limit order price, the poorer is his investment performance. This is true for individual investors, but not true for institutional investors as shown in Panels B and C of Table AV in the Appendix. Overall, the results provide compelling evidence to support Hypothesis 2.

E. Two-Stage Regression Analysis

To further support that superstition captures a unique dimension of trading skills, we perform a two-stage regression analysis. In the first stage, we regress superstition index on proxies for other aspects of trading skills.

$$SI_{i,t-1} = \alpha + \beta_1 OrderSize_{i,t-1} + \beta_2 SubRatio_{0\ and\ 5,i,t-1} + \beta_3 Ln(N_{i,t-1}) + \beta_4\ Disposition_{i,t-1} + \beta_5 Return_{i,t-1} + \varepsilon_{i,t-1}, \quad (5)$$

where $OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year *t-1*, $SubRatio_{0\ and\ 5,i,t-1}$ is investor *i*'s submission ratio at prices ending with "0" and "5" in year *t-1*,

[30] We also perform a double sorting analysis where we sort individual investors into quintiles by the superstition index and the submission ratio at the round number prices (the cognitive ability measure in Kuo, Lin, and Zhao, 2015). The result shows that the underperformance of the most superstitious (Q5) individual investors is larger for investors with lower submission ratio at round number prices. This indicates that our superstition index is different from the cognitive ability measure. These results are reported in Table AVI in the Appendix.

$Ln(N_{i,t-1})$ is the log of number of limit orders submitted by investor *i* in the previous year, and $Disposition_{i,t-1}$ is the difference between the durations of losing and winning round-trip trades of investor *i* in yaer *t-1*, divided by their average. $Return_{i,t-1}$ is the average mark-to-market returns or round-trip returns for investor *i* in year *t-1*.

Panel A of Table AVII in the Appendix (first-stage regression) shows that superstition is significantly related to other aspects of trading skill. The wealthier and more experienced investors have lower superstition indices, while investors who are more affected by the disposition effect tend to be more superstitious.

We take the residuals from Eq. (5) and perform the following second stage regression. By doing so, we single out the effect of superstition from other aspects of trading skills.

$$Return_{i,t} = \alpha + \beta_1 Residual_{SI\,i,t-1} + \beta_2 OrderSize_{i,t-1} + \beta_3 SubRatio_{0,i,t-1} + \beta_4 Ln(N_{i,t-1}) + \beta_5\, Disposition_{i,t-1} + \beta_6 Return_{i,t-1} + \varepsilon_{i,t} \quad (6)$$

Panel B of Table AVII in the Appendix (second-stage regression) presents the results of our second stage regression. They show that the residual superstition index, which is the portion of superstition that cannot be explained by other known trading characteristics, is still negatively associated with investment performance. In particular, the coefficients of limit order returns are all significantly negative. This implies that superstition does capture a unique dimension of trading skills that is related to investment performance.

F. Placebo Tests

To show that our negative association between superstition and investment performance is not a statistical fluke, we conduct two placebo tests in this subsection. The first and the natural one is to check the negative link between superstition and trading performance for institutional investors. Since the limit order submission of institutional investors is supposedly not affected by the lucky/unlucky numbers, the

superstition index should not be associated with investment performance for these investors. This is exactly what we find in Panel B (domestic institutions) and Panel C (QFII) of Table AV in the Appendix.

For the second placebo test, we construct a pseudo superstition index based on the difference between the submission ratios at "7" and "3," and repeat the regression analysis of Eq. (4). The numbers "7" and "3" are deemed neither lucky nor unlucky in Chinese culture. Therefore, the pseudo superstition index should not capture the degree of superstition among investors, nor should it be linked to investment performance.

Table AVIII in the Appendix shows that the negative association does not exist between the pseudo superstition index and investment performance among individual investors. The parameter estimates of β_1 are not significant at the 10% level in any of the columns. We also consider two more pseudo superstition indices: the differences between submission ratios at "7" and "2" and at "2" and "3." We do not find significant association between these two pseudo superstition indices and investment performance either (results not tabulated). This further corroborates our Hypothesis 2 that superstitious individual investors, who tend to favor the number "8" and avoid the number "4," incur worse investment performance than their non-superstitious counterparts.

G. The Lucky vs. Unlucky Side of Superstition Index

The superstition index consists of two parts: the submission ratio at "8" (the lucky number part) and the submission ratio at "4" (the unlucky number part). In this subsection, we examine if the association between superstition and investment performance is driven by a particular part. We consider the lucky part of the superstition index as the difference between the submission ratios at "8" and "3," while the unlucky one as the difference between the submission ratios at "3" and "4." Number "3" is ideal to serve as a benchmark because it is a neutral number that is neither a round number nor adjacent to the round numbers like "0" and "5." We also use the number "2" as a benchmark, and find similar results (not reported).

We repeat the regression analysis of Eq. (4) with these two proxies for the lucky and unlucky parts of the superstition index as our main variables of interest. Table AIX in the Appendix shows that the negative association between superstition and investment performance exists for both parts, though it is more significant for the lucky part. It indicates that the tendency of individual investors both to favor the number "8" and to avoid the number "4" is negatively related to their investment performance.

V. Why do Superstitious Individual Investors Lose Money?

In this section we explore the potential reasons why superstitious individual investors lose money. In financial markets, there are only two ways in which investors could lose by trading: picking the wrong investment and/or picking it at the wrong time. In our setting, the only investment is the index futures. So the only way for individual investors to lose money would be bad market timing. We first investigate whether superstitious investors exhibit poor market timing and then examine how it happens.

A. Market Timing

Following Seasholes and Zhu (2010), we calculate the Buy Ratio and Buy-Sell Ratio for individual investors with various superstition indices and under different market returns to gauge their market timing abilities. The Buy Ratio is defined as the number of buy contracts (taking long positions) scaled by total number of executed contracts. We calculate the Buy-Sell Ratio as the difference between the numbers of buy and sell contracts, divided by their average. Both open limit and market orders are included in the calculation of Buy Ratio and Buy-Sell Ratio. If superstitious investors are indeed poor market timers, we would expect them to have lower Buy Ratio and Buy-Sell Ratio, compared with their non-superstitious counterparts, on the trading days with high market returns.

We first sort individual investors into quintiles by the superstition index in one year. Investors in the superstitious index quintile 5 (Q5) are the most superstitious. We then sort the trading days of the next year into quintiles based on the daily market returns. Market returns on trading days in Quintile-5 (M5)

are the highest. We then compute the average Buy Ratio and average Buy-Sell Ratio of each product (MXF or TXF orders with all available maturity dates) for the investors in each superstitious quintile and market return quintile.

The results are reported in Table V. The last row of Panel A in Table V shows that the difference between the Buy Ratios of M5 and M1 market returns is significantly negative (-0.122) for Q5 individual investors. The result indicates that Q5 individual investors (the most superstitious ones) tend to establish larger long positions on the trading days with lower market returns than on the trading days with higher market returns. In contrast, this difference is insignificant (-0.012) for Q1 individual investors (the least superstitious ones). This suggests that Q5 individual investors in general have poorer market timing ability than their Q1 counterparts. Furthermore, we can see that such a difference in marketing timing ability between Q5 and Q1 investors is mainly manifest on the trading days with low market returns. So Q5 investors buy more than Q1 investors in low market return days, but the difference is not significant in high market return days. Panel B of Table V shows similar results for Buy-Sell Ratio. This evidence suggests that indeed bad market timing is responsible for the underperformance of the most superstitious investors.

(INSERT TABLE V HERE)

We also conduct a placebo test to see if we can replicate the results of Table V based on a pseudo superstition index – the difference between the submission ratios at "7" and "3" – instead of the actual superstition index – the difference between the submission ratios at "8" and "4". According to the results shown in Table AX in the Appendix, we notice no relation between the pseudo-superstition index and market timing ability.

B. Stale Limit Orders

Why are superstitious investors poor market timers? It could be the case that individual investors submit their limit orders without active monitoring, and then their orders become stale and eventually get

picked off by active traders. Linnainmaa (2010) shows that stale limit orders can partly explain the poor performance of individual investors in Finland. In order to check if individual limit orders become stale after submission, we examine the time-to-execution and time-to-cancellation of the orders in this subsection.

Time-to-execution is the time elapsed between order submission and order execution for executed limit orders. Time-to-cancellation is the time elapsed between order submission and order cancellation for limit orders that are submitted and then deleted by individual investors. Both measures can serve as an indicator of how actively investors monitor their limit orders. We first sort individual investors into quintiles according to their superstition indices in one year, and plot the average time-to-execution (cancellation) of limit orders submitted at prices ending with "X" in the subsequent year. X is an integer ranging from 0 to 9. As usual, investors in Quintile-5 (Q5) are the most superstitious.

Figure 2.A shows that for the limit orders submitted at various prices, Q5 investors have longer time-to-execution than Q1 investors. Similarly, Figure 2.B shows that the time-to-cancellation is also longer for Q5 investors at all price points. The differences in time-to-execution (cancellation) of Q5 and Q1 investors are significant (results not tabulated). In sum, our results are consistent with the conjecture that the limit orders of the most superstitious individual investors are left unattended in the limit order book for a longer time such that they become stale and eventually get picked off, partially contributing to their underperformance.

(INSERT FIGURE 2 HERE)

We also perform a regression analysis to show that the time-to-execution and time-to-cancellation are indeed related to investment performance. Table AXI in the Appendix shows that investors who have stale limit orders, namely, investors with longer time-to-execution and longer time-to-cancellation, tend to incur poorer investment performance. This must be because someone is exploiting their predictable trades by, for example, picking off their stale limit orders. The question is: who are these investors? We show that institutional investors, both domestic and foreign, make money at all price points from the most

superstitious traders. As shown in Figure A5 in the Appendix, both domestic and foreign intuitional investors earn more higher positive returns at all price points when they pick up the orders submitted by Q5 individual investors as compared to those submitted by Q1 individual investors. Our results indicate that the superstitious individual investors are losing to the more sophisticated institutional investors.

VI. Superstition and Learning by Trading

In this section, we examine whether individual investors learn by trading to mitigate or reinforce their reliance on superstition in limit order submissions, as proposed by our Hypotheses 3.A and 3.B, respectively. Specifically, we perform the following regression:

$$\begin{aligned} SI_{i,t} - SI_{i,t-1} = \alpha + \beta_1 Ln(N_{i,t-1}) + \beta_2 Return_{8,i,t-1} + \beta_3 Return_{4,i,t-1} + \beta_4 Return_{other,i,t-1} \\ + \beta_5 Return_{market,i,t-1} + \beta_6 SI_{i,t-1} + \beta_7 OrderSize_{i,t-1} + \beta_8 SubRatio_{0\ and\ 5,i,t-1} \\ + \beta_9 Disposition_{i,t-1} + \varepsilon_{i,t}, \end{aligned} \quad (7)$$

where $SI_{i,t}$ and $SI_{i,t-1}$ are the superstition indices of investor *i* in years *t* and *t-1*. We use the change in superstition index to control for unobserved time-invariant investor characteristics. $Ln(N_{i,t-1})$ is the log of the number of limit orders submitted by investor *i* in year *t-1*. $Return_{8,i,t-1}$ is the mark-to-market intraday return of limit orders submitted by investor *i* at prices ending with "8" in year *t-1*. $Return_{4,i,t-1}$ is the mark-to-market intraday return of limit orders submitted by investor *i* at prices ending with "4" in year *t-1*. $Return_{others,i,t-1}$ is the mark-to-market intraday return of limit orders submitted by investor *i* at prices ending with other numbers in year *t-1*. $Return_{market,i,t-1}$ is the mark-to-market intraday return of market orders submitted by investor *i* in year *t-1*. We also control for the past superstition index, wealth, disposition effect, and the round-number submission ratio. The superstition index is expressed in percentage to facilitate comparison of estimated coefficients. The coefficients of interest are β_1, β_2, β_3, β_4, and β_5, as they measure whether investors learn from past trading frequency and past performance, respectively.

Table VI shows that the change in the superstition index is significantly negatively related to the number of limit orders submitted by individual investor in the previous year. According to the estimated β_1 in Model 6, a one-standard-deviation (51 limit orders) increase in the number of submitted limit orders in the previous year will lead to 0.74% more reduction of the superstition index in the subsequent year. This indicates that individual investors learn from their past trading frequency and rely less on superstitious heuristics in their limit order submission.

The significantly negative coefficients of $Return_{other,i,t-1}$ suggest that individual investors with better performance of non-superstitious limit orders are able to learn to become less superstitious. In contrast, the coefficients of $Return_{8,i,t-1}$ and $Return_{4,i,t-1}$ are statistically insignificant, indicating that individual investors do not learn in a reinforcement way. This result is not surprising as we have shown in Tables AII, AIII, AIV, and Figure A4 that superstitious individual investors perform poorly at all numbers. For the most superstitious investors, there seems to be no particularly high return at "8" or a particularly low return on "4," compared with other numbers; so it is likely that that these investors do not learn from performance of limit orders submitted at these lucky/unlucky numbers. In sum, our results are consistent with Hypothesis 3.A that individual investors learn by trading to alleviate their number superstition in limit order submissions.

(INSERT TABLE VI HERE)

Does the effect of trading experience diminish over time? We reproduce Table VI by replacing $Ln(N_{i,t-1})$ with $Ln(N_{i,t-2})$ and $Ln(N_{i,t-3})$, respectively. Doing so allows us to examine the relative importance of the past trading experience accumulated two or three years before. Table AXII in the Appendix shows that the $\beta_1$of $Ln(N_{i,t-2})$ is less negative than that of $Ln(N_{i,t-1})$, and the $\beta_1$of $Ln(N_{i,t-3})$ is insignificant. Our results suggest that the impact of the past trading frequency is diminishing over time.

VII. Conclusion

This paper documents that individual investors exhibit number superstition when submitting limit orders. The limit order submission ratio at the lucky number "8" is 0.098, which is significantly higher

than 0.063, the submission ratio at the unlucky number "4." We also find that there exist both persistence and cross-sectional heterogeneity in the degree that investors are affected by their superstitious beliefs.

We construct an investor-level superstition index based on the limit order submission ratios at lucky and unlucky numbers and show that this index is negatively related to investment performance. Specifically, we find that more superstitious individual investors incur significantly lower intraday, 1-day, and 5-day mark-to-market index returns of their limit orders. In addition, we find similar underperformance of superstitious individual investors for their market orders and round-trip trades. The negative association between superstition index and subsequent investment performance remains significant even after controlling for known investor characteristics that have been shown in the literature to be related to investment performance. Thus, our findings show that the number superstition captures a distinct aspect of investors' trading skills.

Finally, we find that superstitious individual investors underperform because they have bad market timing (mostly because they buy on days when the market return are low) and have stale limit orders which get picked off by smarter traders. The good news is that individual investors can learn from their trading experience and become less superstitious.

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Table I. Descriptive Statistics of Limit Order Quotes and Trades

This table reports the summary statistics of the limit orders quotes and trades for two major Taiwan index futures in the Taiwan Futures Exchange from January 2003 to September 2008. In 2008, we only have orders and trades data from January to September. The number of submitted limit orders and the number of executed limit order contracts are reported in Panels A and B, respectively. The number of limit orders (contracts) is reported separately for individual investors, domestic institutions, and Qualified Foreign Institutional Investors (QFII) and for Taiwan Stock Exchange Futures (TXF) and Mini-Taiwan Stock Exchange Futures (MXF).

Panel A: Number of Limit Orders Submitted

Year	Total	Investor type			Product type	
		Individual	Domestic Institutions	QFII	TXF	MXF
2003	8,391,970	7,874,288	450,329	67,353	5,931,492	2,460,478
2004	11,756,902	10,436,137	1,181,927	138,838	7,935,143	3,821,759
2005	9,336,187	7,171,025	1,866,537	298,625	6,853,377	2,482,810
2006	16,080,187	10,088,540	5,160,370	831,277	11,136,616	4,943,571
2007	26,218,095	13,297,493	11,732,794	1,187,808	15,728,641	10,489,454
2008	36,699,943	18,251,513	16,677,852	1,770,578	21,843,993	14,855,950
Total	108,483,284	67,118,996	37,069,809	4,294,479	69,429,262	39,054,022
Ratio	100%	61.87%	34.17%	3.96%	64.00%	36.00%

Panel B: Number of Limit Order Contracts Executed

Year	Total	Investor type			Product type	
		Individual	Domestic Institutions	QFII	MXF	TXF
2003	15,662,806	13,369,496	1,960,223	333,087	13,029,382	2,633,424
2004	21,609,094	17,067,248	3,667,074	874,772	17,722,556	3,886,538
2005	16,011,798	11,495,469	3,445,196	1,071,133	13,834,750	2,177,048
2006	23,351,164	16,690,861	5,288,886	1,371,417	19,829,998	3,521,166
2007	29,554,384	20,294,809	6,882,178	2,377,397	23,626,300	5,928,084
2008	36,963,929	25,873,811	8,470,446	2,619,672	25,871,823	11,092,106
Total	143,153,175	104,791,694	29,714,003	8,647,478	113,914,809	29,238,366
Ratio	100%	73.20%	20.76%	6.04%	79.58%	20.42%

Table II. Submission Ratio at Prices Ending with "X"

This table reports the parameter estimates of the following regression:

$$SubRatio_X - 0.1 = \alpha + \beta_1 D_8 + \beta_2 D_4 + \beta_3 D_0 + \beta_4 D_5 + (\beta_5 D_8 + \beta_6 D_4 + \beta_7 D_0 + \beta_8 D_5) \times D_{indv} + (\beta_9 D_8 + \beta_{10} D_4 + \beta_{11} D_0 + \beta_{12} D_5) \times D_{QFII} + (\beta_{13} D_8 + \beta_{14} D_4 + \beta_{15} D_0 + \beta_{16} D_5) \times D_{MXF} + (\beta_{17} D_8 + \beta_{18} D_4 + \beta_{19} D_0 + \beta_{20} D_5) \times D_{indv} \times D_{MXF} + (\beta_{21} D_8 + \beta_{22} D_4 + \beta_{23} D_0 + \beta_{24} D_5) \times D_{QFII} \times D_{MXF} + \beta_{25} D_{indv} + \beta_{26} D_{QFII} + \beta_{27} D_{MXF} + \varepsilon_X$$

$SubRatio_X$ is the submission ratio at "X", which is calculated as the number of limit orders submitted at prices ending with "X" divided by total number of limit orders submitted at all prices (X is an integer ranging from 0 to 9). The dependent variable is the deviation of the actual submission ratio at "X" from its theoretical value assuming uniform distribution of the limit order prices. Each year, the submission ratio at "X" is calculated separately for individual investors, domestic institutions, and QFII investors, and for MXF and TXF orders. D_8, D_4, D_0, and D_5 are dummy variables for X=8, 4, 0, and 5, respectively. D_{indv} and D_{QFII} are indicators for individual and QFII investors. D_{MXF} is equal to 1 if the order is to trade MXF, and 0 if it is to trade TXF. In the last three rows we report the F-tests for the equality of coefficients. Standard errors are adjusted for heteroskedasticity. *, **, and *** indicate significance levels of 0.1, 0.5 and 0.01, respectively.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5
D_8	0.013***	0.004	0.011***	0.002	0.002
	(0.000)	(0.134)	(0.000)	(0.479)	(0.544)
D_4	-0.004	0.002	-0.003	0.003	-0.002
	(0.243)	(0.456)	(0.359)	(0.418)	(0.503)
D_0	0.111***	0.041***	0.086***	0.016	0.037***
	(0.000)	(0.000)	(0.000)	(0.182)	(0.000)
D_5	0.045***	0.009***	0.035***	-0.001	0.008**
	(0.000)	(0.008)	(0.000)	(0.810)	(0.021)
Double Interactions					
$D_8 \times D_{indv}$		0.020***		0.020***	0.021***
		(0.000)		(0.000)	(0.000)
$D_4 \times D_{indv}$		-0.013***		-0.013***	-0.007*
		(0.001)		(0.001)	(0.067)
$D_0 \times D_{indv}$		0.142***		0.142***	0.124***
		(0.000)		(0.000)	(0.000)
$D_5 \times D_{indv}$		0.069***		0.069***	0.060***
		(0.000)		(0.000)	(0.000)
$D_8 \times D_{QFII}$		0.005		0.005	0.006
		(0.382)		(0.372)	(0.225)
$D_4 \times D_{QFII}$		-0.007		-0.006	0.003
		(0.394)		(0.399)	(0.572)
$D_0 \times D_{QFII}$		0.068***		0.068***	0.024*
		(0.006)		(0.003)	(0.099)
$D_5 \times D_{QFII}$		0.039***		0.039***	0.018**
		(0.000)		(0.000)	(0.033)
$D_8 \times D_{MXF}$			0.004	0.004	0.005
			(0.277)	(0.264)	(0.412)

$D_4 \times D_{MXF}$			-0.002	-0.002	0.009
			(0.801)	(0.720)	(0.149)
$D_0 \times D_{MXF}$			0.050**	0.050***	0.008
			(0.030)	(0.002)	(0.672)
$D_5 \times D_{MXF}$			0.021**	0.021***	0.002
			(0.028)	(0.003)	(0.793)
Triple Interactions					
$D_8 \times D_{indv} \times D_{MXF}$					-0.001
					(0.927)
$D_4 \times D_{indv} \times D_{MXF}$					-0.012**
					(0.042)
$D_0 \times D_{indv} \times D_{MXF}$					0.036*
					(0.091)
$D_5 \times D_{indv} \times D_{MXF}$					0.017**
					(0.032)
$D_8 \times D_{QFII} \times D_{MXF}$					-0.001
					(0.903)
$D_4 \times D_{QFII} \times D_{MXF}$					-0.019
					(0.134)
$D_0 \times D_{QFII} \times D_{MXF}$					0.089**
					(0.034)
$D_5 \times D_{QFII} \times D_{MXF}$					0.042**
					(0.019)
D_{indv}		-0.022***		-0.022***	-0.022***
		(0.000)		(0.000)	(0.000)
D_{QFII}		-0.008**		-0.008**	-0.008**
		(0.015)		(0.015)	(0.016)
D_{MXF}			-0.006**	-0.006**	-0.006**
			(0.025)	(0.014)	(0.015)
Constant	-0.012***	-0.002	-0.009**	0.001	0.001
	(0.008)	(0.613)	(0.023)	(0.806)	(0.821)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
Number of obs.	357	357	357	357	357
Adjusted R^2	0.581	0.751	0.606	0.779	0.797
F-test					
$D_8 - D_4$	0.017***	0.002	0.014***	-0.001	0.004
	(0.000)	(0.578)	(0.000)	(0.833)	(0.305)
$D_8 \times D_{indv} - D_4 \times D_{indv}$		0.033***		0.033***	0.028***
		(0.000)		(0.000)	(0.000)
$D_8 \times D_{QFII} - D_4 \times D_{QFII}$		0.012		0.011	0.003
		(0.161)		(0.157)	(0.685)
$D_8 \times D_{MXF} - D_4 \times D_{MXF}$			0.006	0.006	-0.004
			(0.394)	(0.260)	(0.624)
$D_8 \times D_{indv} \times D_{MXF} - D_4 \times D_{indv} \times D_{MXF}$					0.011
					(0.169)
$D_8 \times D_{indv} \times D_{MXF} - D_4 \times D_{indv} \times D_{MXF}$					0.018
					(0.247)

Table III. Superstition Index and Related Individual Investor Traits

In this table we report the correlations between the superstition index and other individual investor traits. $SI_{i,t-1}$ and $SI_{i,t}$ are investor *i*'s superstition indices in two consecutive years *t-1* and *t*, calculated as the difference between limit order submission ratios at "8" and "4." In each year, we calculate the investor's submission ratio at "8" as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices. The submission ratio at "4" is calculated in a similar fashion. $OrderSize_{i,t}$ is the average number of contracts per limit order submitted by investor *i* in year *t*. $SubRatio_{0\ and\ 5,i,t}$ is investor *i*'s submission ratio in year *t* at prices ending with "0" and "5." $Ln(N_{i,t})$ is the log of number of limit orders submitted by investor *i* within year *t*. $Disposition_{i,t}$ is the difference between the durations of losing and winning round-trip trades of investor *i* in year *t*, divided by their average. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. The p-values are reported in parentheses. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Correlations	$SI_{i,t}$	$SI_{i,t-1}$	$OrderSize_{i,t}$	$SubRatio_{0\ and\ 5,i,t}$	$Ln(N_{i,t})$	$Disposition_{i,t}$
$SI_{i,t}$	1.0000					
$SI_{i,t-1}$	0.4205***	1.0000				
	(0.000)					
$OrderSize_{i,t}$	-0.0229***	-0.0223***	1.0000			
	(0.000)	(0.000)				
$SubRatio_{0\ and\ 5,i,t}$	-0.0821***	-0.1134***	-0.0409***	1.0000		
	(0.000)	(0.000)	(0.000)			
$Ln(N_{i,t})$	0.0043***	-0.0037	0.0894***	-0.1915***	1.0000	
	(0.0936)	(0.1474)	(0.000)	(0.000)		
$Disposition_{i,t}$	0.0475***	0.0421***	-0.0322***	-0.0185***	0.0790***	1.0000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

Table IV. Superstition Index and Investment Performance of Individual Investors – Quintile Analysis

In this table, we sort individual investors into quintiles by the superstition index in one year, and report their returns in the subsequent year. Panel A shows the mark-to-market returns of limit orders. Panel B shows the mark-to-market returns of market orders. Mark-to-market intraday return is the difference between the trade price and the daily closing price divided by the trade price. Mark-to-market 1-day and 5-day returns are calculated in a similar fashion. Panel C shows the performance of round-trip trades. Round-trip duration is the number of trading days between the initiating and closing positions of a round-trip trade. For each investor, we calculate the round-trip daily profit and daily index return as the average round-trip profit or index return divided by the average round-trip duration. In all panels, Quintile-5 (Q5) investors are more superstitious. In each year, we calculate the superstition index for each investor as the difference between limit order submission ratios at "8" and "4." We calculate the investor's submission ratio at "8" as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices. The submission ratio at "4" is calculated in a similar fashion. All items are first calculated for each investor-year observation and then averaged for each quintile with equal weights. To ensure a reasonable magnitude of superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. The Satterthwaite p-value assumes unequal variances of investor performance in quintiles 1 and 5. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Panel A: Mark-To-Market Returns of Limit Orders

Quintile Ranks	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
Intraday (%)	-0.078	-0.088	-0.087	-0.086	-0.095	-0.017***	0.000
1-day (%)	-0.111	-0.136	-0.126	-0.128	-0.135	-0.024***	0.000
5-day (%)	-0.179	-0.240	-0.219	-0.211	-0.242	-0.063***	0.000

Panel B: Mark-To-Market Returns of Market Orders

Quintile Ranks	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
Intraday (%)	-0.039	-0.055	-0.048	-0.055	-0.052	-0.013**	0.015
1-day (%)	-0.070	-0.097	-0.101	-0.099	-0.099	-0.030**	0.011
5-day (%)	-0.146	-0.11	-0.192	-0.195	-0.203	-0.056**	0.015

Panel C: Round-Trip Performance

Quintile Ranks	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
Round-trip daily profit (TWD)	-1,002	-1,690	-1,526	-2,322	-2,201	-1,199*	0.096
Round-trip daily index return (%)	-0.076	-0.135	-0.134	-0.195	-0.181	-0.105*	0.065
Number of round-trip trades	61	58	67	54	43	-18***	0.000
Round-trip duration (day)	2.256	2.555	2.273	2.293	2.570	0.314***	0.000
Duration of winning round-trips (day)	1.922	2.130	1.908	1.875	2.086	0.164***	0.000
Duration of losing round-trips (day)	3.010	3.456	3.109	3.204	3.619	0.609***	0.000

Table V. Individual Investors' Superstition Index, Market Return, and the Buy Ratio and Buy-sell Ratio – Quintile Analysis

In this table we report the Buy Ratio and Buy-sell Ratio for individual investors with various superstition indices and under different market returns. We first sort individual investors into quintiles by the superstition index in one year. Investors in quantile 5 (Q%) of the superstitious index are the most superstitious. We then sort the trading days of the next year into quintiles based on the daily market returns. Market returns on trading days in Quintile-5 (M5) are the highest. We then compute the average Buy Ratio and average Buy-Sell Ratio of each product (MXF or TXF orders that expire in one month, two months, three months, six months, nine months, or one year) for the investors in each superstitious quintile and market return quintile. We define $SI_{i,t-1}$ as the difference between limit order submission ratios at "8" and "4" for investor *i* in year *t-1*. We calculate the investor's submission ratio at "8" as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices. The submission ratio at "4" is calculated in a similar fashion. The Buy Ratio is calculated as the number of buy contracts (taking long positions) scaled by total number of executed contracts. We calculate the Buy-sell Ratio as the difference between the numbers of buy and sell contracts, divided by their average. Both limit and market orders are included in the calculation of Buy Ratio and Buy-sell Ratio. To ensure a reasonable magnitude of superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. The Satterthwaite p-value assumes unequal variances of investor performance in quintiles 1 and 5. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Panel A: Buy Ratio

Quintile Ranks of	Quintile Ranks of $SI_{i,t-1}$						
Market Return	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
M1	0.625	0.667	0.633	0.678	0.723	0.098***	0.000
M2	0.587	0.618	0.613	0.635	0.659	0.073***	0.000
M3	0.595	0.608	0.613	0.623	0.640	0.045***	0.000
M4	0.625	0.605	0.611	0.614	0.630	0.004	0.593
M5	0.614	0.583	0.604	0.603	0.601	-0.013	0.107
Diff (M5-M1)	-0.012	-0.084***	-0.029***	-0.076***	-0.122***		
p-value	0.157	0.000	0.000	0.000	0.000		

Panel B: Buy-Sell Ratio

Quintile Ranks of Market Return	Quintile Ranks of $SI_{i,t-1}$						
	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
M1	0.502	0.668	0.533	0.713	0.893	0.391***	0.000
M2	0.346	0.473	0.450	0.540	0.636	0.290***	0.000
M3	0.380	0.433	0.451	0.490	0.559	0.178***	0.000
M4	0.502	0.419	0.446	0.457	0.519	0.017	0.593
M5	0.455	0.333	0.415	0.411	0.403	-0.052	0.107
Diff (M5-M1)	-0.047	-0.335***	-0.118***	-0.302***	-0.490***		
p-value	0.157	0.000	0.000	0.000	0.000		

Table VI. Investors' Learning and Superstition

In this table we report the parameter estimates from the following regression for individual investors:

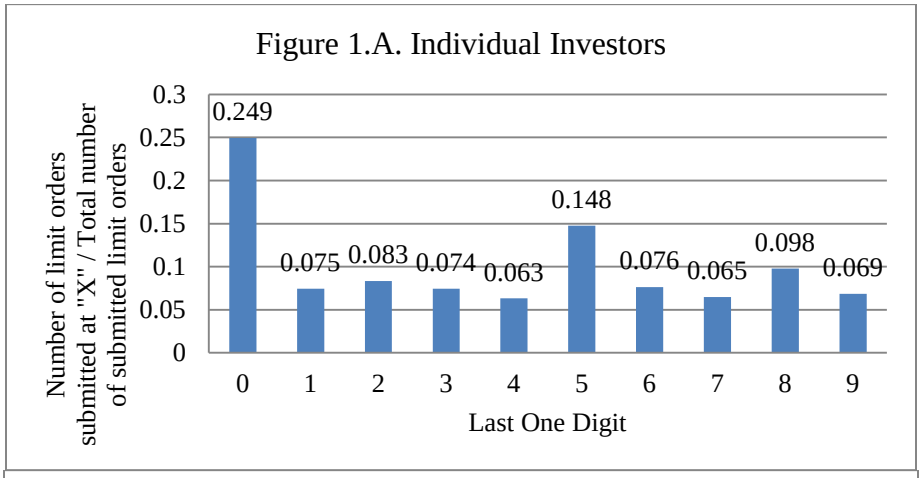
$$SI_{i,t} - SI_{i,t-1} = \alpha + \beta_1 Ln(N_{i,t-1}) + \beta_2 Return_{8,i,t-1} + \beta_3 Return_{4,i,t-1} + \beta_4 Return_{other,i,t-1} + \beta_5 Return_{market,i,t-1} + \beta_6 SI_{i,t-1} + \beta_7 OrderSize_{i,t-1} + \beta_8 SubRatio_{0\ and\ 5,i,t-1} + \beta_9 Disposition_{i,t-1} + \varepsilon_X$$

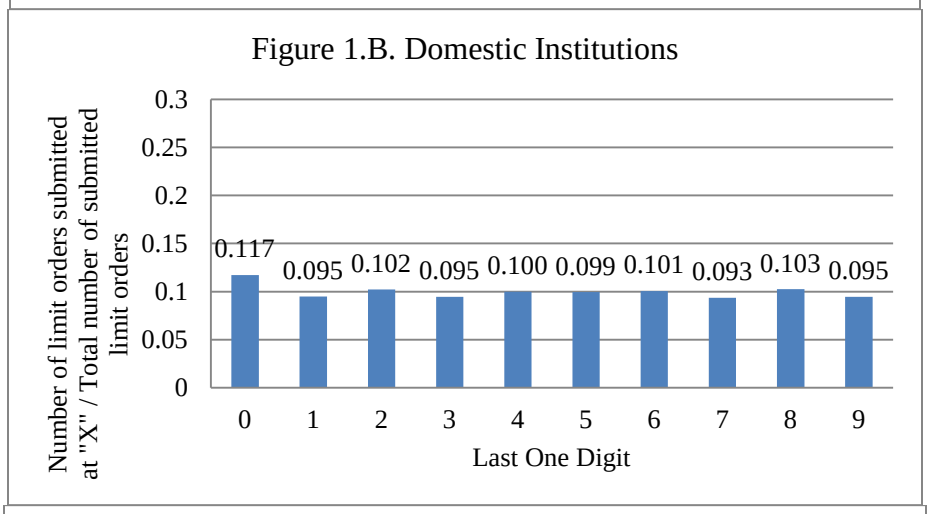
where $SI_{i,t}$ and $SI_{i,t-1}$ are the superstition indices in year *t* and *t-1*, and they are calculated as the difference between limit order submission ratios at "8" and "4" in each year. We calculate the investor's submission ratio at "8" as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices. The submission ratio at "4" is calculated in a similar fashion. $Ln(N_{i,t-1})$ is the log of the number of limit orders submitted at year *t-1*. $Return_{8,i,t-1}$ is the mark-to-market intraday return of limit orders submitted at prices ending with "8" at year *t-1*. $Return_{4,i,t-1}$ is the mark-to-market intraday return of limit orders submitted at prices ending with "4" at year *t-1*. $Return_{others,i,t-1}$ is the mark-to-market intraday return of limit orders submitted at prices ending with other numbers at year *t-1*. $Return_{market,i,t-1}$ is the mark-to-market intraday return of market orders at year *t-1*. $OrderSize_{i,t-1}$ is the average number of contracts per limit order at year *t-1*. $SubRatio_{0\ and\ 5,i,t-1}$ is the sum of investor *i*'s submission ratios at prices ending with "0" and "5" at year *t-1*. $Disposition_{i,t-1}$ is the disposition effect, which is calculated as the difference between winning and losing round-trip trades, divided by the average of the two at year *t-1*. We require that investors must submit at least 10 limit orders in each of the two consecutive years, and we express the superstition index in percentage. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Independent Variables	$SI_{i,t} - SI_{i,t-1}$ (%)					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
$Ln(N_{i,t-1})$	-0.096***					-0.188***
	(0.000)					(0.000)
$Return_{8,i,t-1}$ (%)		-0.053				-0.103
		(0.449)				(0.343)
$Return_{4,i,t-1}$ (%)			-0.040			-0.052
			(0.581)			(0.602)
$Return_{other,i,t-1}$ (%)				-0.354**		-0.767**
				(0.031)		(0.018)
$Return_{market,i,t-1}$ (%)					0.036	0.032
					(0.709)	(0.772)
$SI_{i,t-1}$ (%)	-0.434***	-0.368***	-0.414***	-0.434***	-0.421***	-0.333***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$OrderSize_{i,t-1}$	-0.047***	-0.031**	-0.054***	-0.050***	-0.040***	-0.013
	(0.000)	(0.015)	(0.000)	(0.000)	(0.001)	(0.293)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.932***	-0.855***	0.255	-0.823***	-0.539***	-0.017
	(0.000)	(0.000)	(0.127)	(0.000)	(0.001)	(0.940)
$Disposition_{i,t-1}$	0.279***	0.294***	0.258***	0.265***	0.188***	0.207***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.003)
Constant	2.785***	1.653***	1.767***	2.243***	2.059***	2.274***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	56,260	47,462	40,029	56,169	32,890	22,298
Adjusted R^2	0.168	0.128	0.140	0.167	0.150	0.090

Figure 1. Limit Order Submission Ratios at Various Prices

In this figure, we report the limit order submission ratios at prices ending with "X" (X is an integer ranging from 0 to 9). The submission ratio at "X" is calculated as the number of limit orders submitted at "X" divided by the total number of submitted limit orders. We report the figures separately for individual investors, domestic institutions, and Qualified Foreign Institutional Investors (QFIIs.)





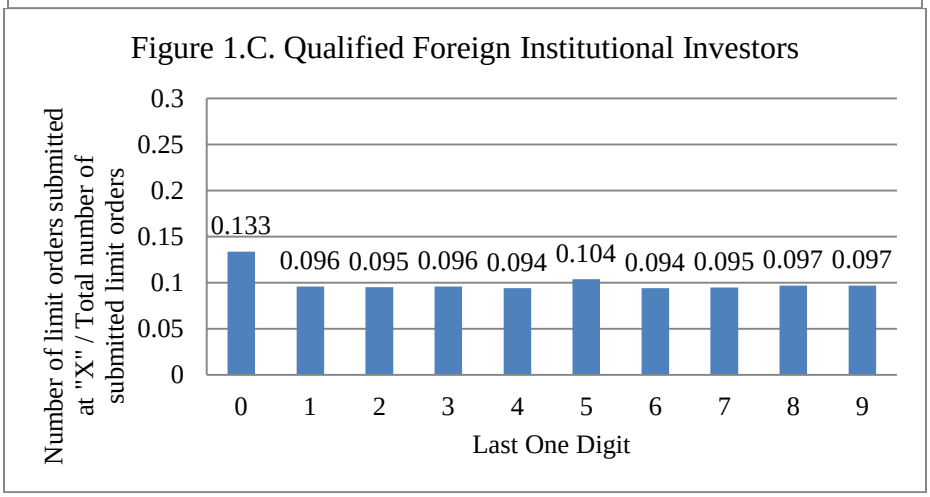
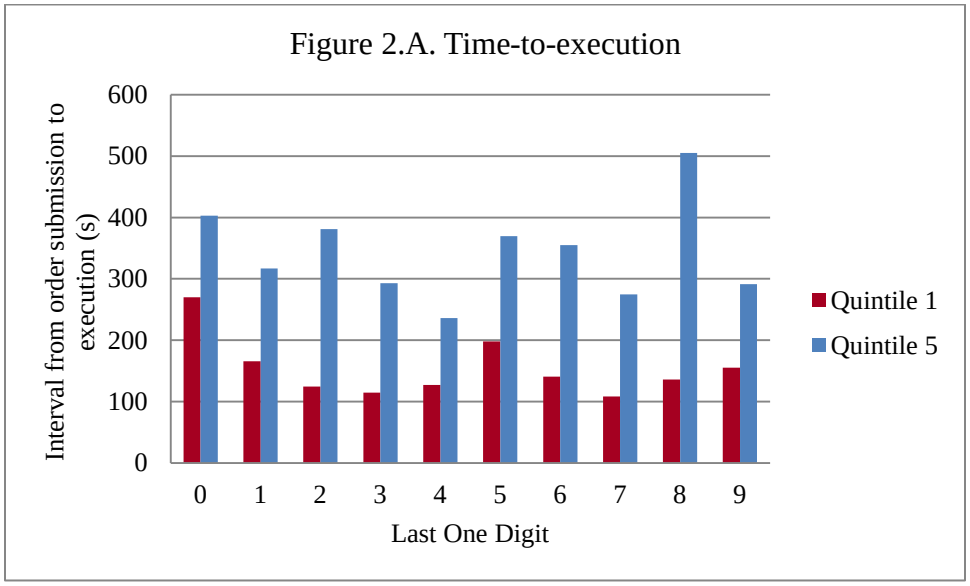
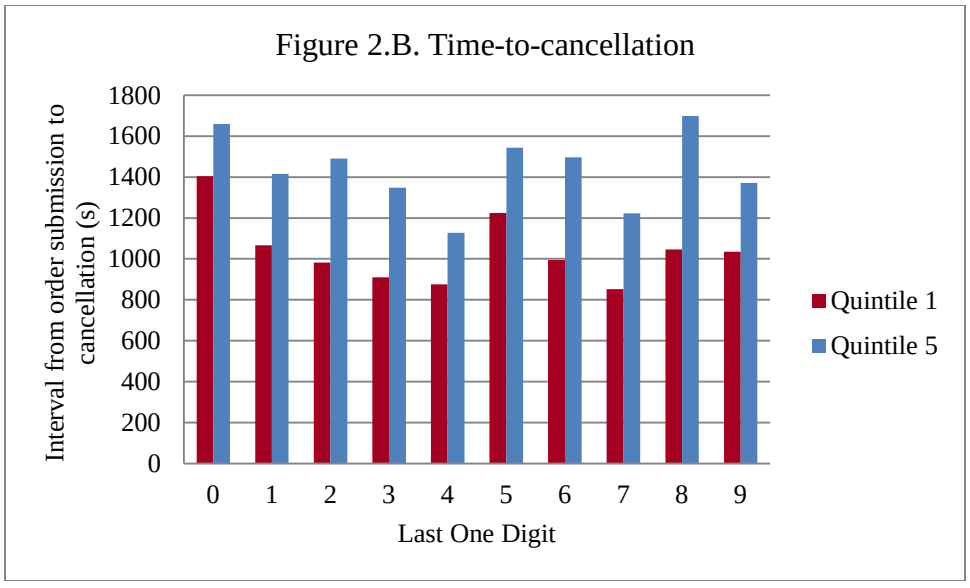


Figure 2. Time-to-execution and Time-to-cancellation of Individual Investors' Limit Orders

In this table we sort individual investors into quintiles by the superstition index in one year, and plot the time-to-execution and time-to-cancellation of limit orders submitted at prices ending with "X" in the subsequent year. (X is an integer ranging from 0 to 9). Quintile-5 (Q5) investors are most superstitious. In each year, we calculate the superstition index for each investor as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices. The submission ratio at "4" is calculated in a similar fashion. Time-to-execution is the interval from order submission to execution for executed limit orders. Time-to-cancellation is the interval from submission to cancellation for orders that are submitted and then deleted by individual investors.





Do Superstitious Traders Lose Money?

The APPENDIX

Utpal Bhattacharya

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Jing Zhao

Table AI. Descriptive Statistics of the Superstition Index

In this table, we report the summary statistics of the investor-level superstition index. In each year, we calculate the superstition index for each investor as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" is calculated in a similar fashion. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. In 2008, we only have data for the first nine months.

Panel A: Individual Investors

Year	Mean	Median	Standard Deviation	20th Percentile	40th Percentile	60th Percentile	80th Percentile
2003	0.0365	0.0292	0.0764	0.0000	0.0152	0.0435	0.0805
2004	0.0408	0.0323	0.0799	0.0000	0.0185	0.0462	0.0833
2005	0.0413	0.0323	0.0848	0.0000	0.0172	0.0476	0.0889
2006	0.0425	0.0324	0.0836	0.0000	0.0189	0.0465	0.0857
2007	0.0424	0.0303	0.0855	0.0000	0.0175	0.0439	0.0833
2008	0.0493	0.0333	0.0909	0.0000	0.0213	0.0474	0.0882

Panel B: Domestic Institutions

Year	Mean	Median	Standard Deviation	20th Percentile	40th Percentile	60th Percentile	80th Percentile
2003	0.0273	0.0158	0.0820	-0.0187	0.0000	0.0321	0.0690
2004	0.0359	0.0241	0.0828	-0.0083	0.0124	0.0364	0.0667
2005	0.0285	0.0223	0.0733	-0.0098	0.0114	0.0364	0.0684
2006	0.0186	0.0132	0.0660	-0.0114	0.0040	0.0270	0.0588
2007	0.0221	0.0146	0.0613	-0.0144	0.0000	0.0258	0.0601
2008	0.0328	0.0192	0.0712	-0.0065	0.0088	0.0313	0.0696

Panel C: Qualified Foreign Institutional Investors

Year	Mean	Median	Standard Deviation	20th Percentile	40th Percentile	60th Percentile	80th Percentile
2003	0.0005	0.0063	0.0356	-0.0258	0.0048	0.0157	0.0232
2004	0.0084	0.0124	0.0223	0.0037	0.0055	0.0140	0.0204
2005	-0.0087	-0.0037	0.0447	-0.0134	-0.0055	0.0000	0.0198
2006	0.0172	0.0063	0.0334	-0.0010	0.0034	0.0098	0.0335
2007	0.0150	0.0099	0.0347	-0.0131	0.0044	0.0176	0.0336
2008	0.0227	0.0131	0.0488	-0.0003	0.0077	0.0233	0.0549

Table AII. Individual Investors' Superstition and Mark-to-market Returns of Limit Orders at "8," "4," "0," and other Numbers – Quintile Analysis

In this table, we sort individual investors into quintiles by the superstition index in one year, and report the subsequent year's mark-to-market return of limit orders submitted at prices ending with "8," "4," "0," and other numbers. Quintile-5 (Q5) investors are more superstitious. In each year, we calculate the superstition index for each investor as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" is calculated in a similar fashion. Mark-to-market intraday return is the difference between the trade price and the daily closing price divided by the trade price. Mark-to-market 1-day and 5-day returns are calculated in a similar fashion. All items are first calculated for each investor-year observation and then averaged for each quintile with equal weights. To ensure a reasonable magnitude of superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. The Satterthwaite p-value assumes unequal variances of investor performance in quintiles 1 and 5. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Quintile Ranks	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
Mark-to-market returns of limit orders submitted at prices ending with "8"							
Intraday (%)	-0.056	-0.056	-0.055	-0.068	-0.073	-0.017***	0.002
1-day (%)	-0.076	-0.102	-0.084	-0.109	-0.110	-0.034***	0.002
5-day (%)	-0.063	-0.153	-0.117	-0.134	-0.166	-0.103***	0.000
Mark-to-market returns of limit orders submitted at prices ending with "4"							
Intraday (%)	-0.054	-0.061	-0.059	-0.061	-0.065	-0.011*	0.099
1-day (%)	-0.081	-0.103	-0.097	-0.095	-0.089	-0.008	0.535
5-day (%)	-0.148	-0.176	-0.172	-0.175	-0.154	-0.006	0.821
Mark-to-market returns of limit orders submitted at prices ending with "0"							
Intraday (%)	-0.074	-0.089	-0.089	-0.084	-0.094	-0.020***	0.000
1-day (%)	-0.111	-0.128	-0.126	-0.119	-0.131	-0.021**	0.016
5-day (%)	-0.185	-0.241	-0.208	-0.183	-0.221	-0.036**	0.042
Mark-to-market returns of limit orders submitted at other prices							
Intraday (%)	-0.076	-0.086	-0.085	-0.084	-0.097	-0.021***	0.000
1-day (%)	-0.110	-0.132	-0.123	-0.128	-0.138	-0.027***	0.000
5-day (%)	-0.179	-0.223	-0.216	-0.217	-0.243	-0.065***	0.000

Table AIII. Individual Investors' Superstition and Mark-to-market Returns of Limit Orders at Prices Ending with "X" – Regression Analysis

In this table, we report the parameter estimates from the following regression:

$$Return_{X,i,t} = \alpha + \beta_1 SI_{i,t-1} + (\beta_2 D_8 + \beta_3 D_4 + \beta_4 D_0) \times SI_{i,t-1} + \beta_5 D_8 + \beta_6 D_4 + \beta_7 D_0 + \beta_8 OrderSize_{i,t-1} + \beta_9 SubRatio_{0\ and\ 5,i,t-1} + \beta_{10} Ln(N_{i,t-1}) + \beta_{11} Disposition_{i,t-1} + \beta_{12} Return_{i,t-1} + \varepsilon_{X,i,t}$$

where $Return_{X,i,t}$ is the performance of individual limit orders submitted at prices ending with "X" for investor *i* in year *t* (X is an integer ranging from 0 to 9). D_8, D_4, and D_0 are dummy variables for X=8, 4, and 0, respectively. Mark-to-market intraday return is the difference between the trade price and the daily closing price divided by the trade price. Mark-to-market 1-day and 5-day returns are calculated in a similar fashion. $SI_{i,t-1}$ is the superstition index of investor *i* in year *t-1*, and it is calculated as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" is calculated in a similar fashion. $OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year t-1. $SubRatio_{0\ and\ 5,i,t-1}$ is the sum of investor *i*'s submission ratios at prices ending with "0" and "5" in year *t-1*. $Ln(N_{i,t-1})$ is the log of the number of limit orders submitted by investor *i* in year *t-1*. $Disposition_{i,t-1}$ is the disposition effect, which is calculated as the difference between the durations of losing and winning round-trip trades of investor *i* in year *t-1*, divided by their average. $Return_{i,t-1}$ is the average intraday, 1-day, or 5-day mark-to-market return for investor *i* in year *t-1*. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Independent Variable	Mark-to-market Return of Limit Orders (%)		
	Intraday	1-day	5-day
$SI_{i,t-1}$	-0.072***	-0.094*	-0.220**
	(0.000)	(0.054)	(0.014)
$SI_{i,t-1} \times D_8$	-0.016	0.046	0.028
	(0.666)	(0.555)	(0.858)
$SI_{i,t-1} \times D_4$	-0.050	-0.162	0.125
	(0.381)	(0.177)	(0.596)
$SI_{i,t-1} \times D_0$	-0.003	-0.082	-0.084
	(0.947)	(0.311)	(0.599)
D_8	0.011***	0.002	0.010
	(0.002)	(0.772)	(0.491)
D_4	0.022***	0.025***	0.032*
	(0.000)	(0.002)	(0.055)
D_0	0.002	0.016***	0.026**
	(0.406)	(0.004)	(0.028)
$OrderSize_{i,t-1}$	0.002***	0.000	-0.002
	(0.000)	(0.624)	(0.230)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.039***	-0.084***	-0.151***
	(0.000)	(0.000)	(0.000)
$Ln(N_{i,t-1})$	0.010***	0.013***	0.010***
	(0.000)	(0.000)	(0.008)

$Disposition_{i,t-1}$	-0.027***	-0.035***	-0.027***
	(0.000)	(0.000)	(0.000)
$Return_{i,t-1}$	0.015***	0.005	0.008**
	(0.000)	(0.185)	(0.026)
Constant	-0.052***	-0.083***	-0.071***
	(0.000)	(0.000)	(0.005)
Year fixed effect	Yes	Yes	Yes
Number of obs.	176,888	176,622	172,041
Adjusted R^2	0.008	0.003	0.005

Table AIV. Number of "X"s Where Superstitious Individual Investors Underperform

In this table, we sort individual investors into quintiles by the superstition index in one year, and examine the performance of limit orders submitted at prices ending with "X" in the subsequent year (X is an integer ranging from 0 to 9). We report the number of "X"s where Quintile-5 investors (significantly) underperform Quintile-1 investors. Quintile-5 (Q5) investors are more superstitious. In each year, we calculate the superstition index for each investor as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" is calculated in a similar fashion. The underperformance is determined based on the intraday, 1-day, as well as 5-day mark-to-market returns of limit orders. Mark-to-market intraday return is the difference between the trade price and the daily closing price divided by the trade price. Mark-to-market 1-day and 5-day returns are calculated in a similar fashion. To ensure a reasonable magnitude of superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. The Satterthwaite p-value assumes unequal variances of investor performance in quintiles 1 and 5. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Significance	Number of "X"s where Q-5 individual investors underperform Q-1 investors		
Level	Intraday	1-day	5-day
p<1	10	10	10
p<0.1	10	10	10
p<0.05	10	10	10
p<0.01	10	10	10

Table AV. Superstition Index and Investment Performance of All Investors – Regression Analysis

In this table we report the parameter estimates for the following panel regression:

$$Return_{i,t} = \alpha + \beta_1 SI_{i,t-1} + \beta_2 OrderSize_{i,t-1} + \beta_3 SubRatio_{0\ and\ 5,i,t-1} + \beta_4 Ln(N_{i,t-1}) + \beta_5\ Disposition_{i,t-1} + \beta_6 Return_{i,t-1} + \varepsilon_{i,t}$$

where $Return_{i,t}$ and $Return_{i,t-1}$ are the average mark-to-market returns or round-trip performance for investor *i* in year *t* and year *t-1*. $SI_{i,t-1}$ is investor *i*'s superstition index in year *t-1*, calculated as the difference between limit order submission ratios at "8" and "4." In each year, we calculate the investor's submission ratio at "8" as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices. The submission ratio at "4" is calculated in a similar fashion. $OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year *t-1*. $SubRatio_{0\ and\ 5,i,t-1}$ is the sum of investor *i*'s submission ratios at prices ending with "0" and "5" in year *t-1*. $Ln(N_{i,t-1})$ is the log of number of limit orders submitted by investor *i* in the previous year. $Disposition_{i,t-1}$ is the difference between the durations of losing and winning round-trip trades of investor *i* in year *t-1*, divided by their average. Mark-to-market return of limit (market) orders is the return under the assumption that the initiating limit (market) orders are covered at the closing price of a trading day. The round-trip daily profit and daily index return are calculated as the average round-trip profit or index return divided by the average round-trip duration for each investor. Results for individual (Panel A) and institutional investors (Panels B and C) are reported separately. Standard errors are adjusted for heteroskedasticity. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Panel A: Individual Investors

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$SI_{i,t-1}$	-0.029***	-0.035*	-0.090**	-0.014	-0.092	-0.198*	-8,589.073*	-0.696*
	(0.003)	(0.094)	(0.045)	(0.627)	(0.120)	(0.090)	(0.065)	(0.064)
$OrderSize_{i,t-1}$	0.001***	-0.000	-0.001	0.000	-0.000	-0.005	-345.576	-0.022
	(0.001)	(0.745)	(0.425)	(0.672)	(0.861)	(0.169)	(0.556)	(0.632)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.023***	-0.050***	-0.096***	-0.017*	-0.050***	-0.076*	14,317.476	1.171
	(0.000)	(0.000)	(0.000)	(0.052)	(0.009)	(0.053)	(0.341)	(0.337)
$Ln(N_{i,t-1})$	0.005***	0.006***	0.004	0.008***	0.009**	0.006	2,450.266	0.200
	(0.000)	(0.000)	(0.189)	(0.000)	(0.012)	(0.427)	(0.209)	(0.205)
$Disposition_{i,t-1}$	-0.009***	-0.016***	-0.011**	-0.012***	-0.015**	-0.003	4,354.670	0.352
	(0.000)	(0.000)	(0.017)	(0.000)	(0.019)	(0.798)	(0.375)	(0.377)
$Return_{i,t-1}$	0.022***	0.010***	0.007**	0.003	-0.001	0.001	0.057**	0.056**
	(0.000)	(0.002)	(0.021)	(0.525)	(0.825)	(0.878)	(0.033)	(0.050)
Constant	-0.101***	-0.132***	-0.269***	-0.048***	-0.077***	-0.144***	-22,735.463	-1.848
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.003)	(0.190)	(0.188)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	140,724	140,700	140,180	53,412	53,260	51,247	140,608	140,608
Adjusted R^2	0.012	0.004	0.008	0.003	0.002	0.002	-0.000	-0.000

Panel B: Domestic Institutions

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$SI_{i,t-1}$	-0.210	-0.630	-1.731	1.067*	1.603	0.909	-30,441.496	-2.953
	(0.250)	(0.164)	(0.136)	(0.090)	(0.108)	(0.697)	(0.852)	(0.804)
$OrderSize_{i,t-1}$	0.001	0.005	0.009	0.003	0.008	0.006	-2,702.743	-0.152
	(0.626)	(0.149)	(0.292)	(0.516)	(0.473)	(0.882)	(0.625)	(0.684)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.094	-0.298*	-0.067	-0.239	-0.239	0.781	-109,654.930**	-4.246
	(0.154)	(0.070)	(0.822)	(0.234)	(0.577)	(0.329)	(0.038)	(0.271)
$Ln(N_{i,t-1})$	-0.002	-0.015	-0.002	-0.003	-0.029	0.021	-43,337.750***	-1.131
	(0.720)	(0.337)	(0.951)	(0.860)	(0.381)	(0.765)	(0.006)	(0.332)
$Disposition_{i,t-1}$	-0.050***	-0.143***	-0.255***	0.051	0.155	0.020	-80,629.523***	-5.759***
	(0.002)	(0.000)	(0.001)	(0.322)	(0.111)	(0.919)	(0.001)	(0.002)
$Return_{i,t-1}$	0.100	-0.033	0.034	-0.107	-0.247	-0.205	0.043	0.008
	(0.140)	(0.645)	(0.480)	(0.340)	(0.129)	(0.110)	(0.817)	(0.965)
Constant	0.045	0.214	0.181	0.091	0.256	-0.351	297,375.906***	8.687
	(0.449)	(0.109)	(0.492)	(0.424)	(0.393)	(0.588)	(0.002)	(0.218)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	563	563	561	259	256	244	554	554
Adjusted R^2	0.024	0.034	0.036	-0.005	0.033	-0.015	0.063	0.035

Panel C: Qualified Foreign Institutional Investors

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$SI_{i,t-1}$	-0.491	-0.558	0.947	3.355*	-2.177	8.292	-3740699.500	-193.907
	(0.441)	(0.750)	(0.763)	(0.083)	(0.619)	(0.162)	(0.190)	(0.314)
$OrderSize_{i,t-1}$	-0.003	0.009	0.008	-0.012	0.037	0.105	26,424.318	1.699
	(0.416)	(0.348)	(0.689)	(0.279)	(0.203)	(0.195)	(0.432)	(0.484)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.021	-0.686**	-1.127**	0.211	-0.237	1.224	-100,800.758	-2.970
	(0.860)	(0.034)	(0.022)	(0.594)	(0.760)	(0.370)	(0.842)	(0.926)
$Ln(N_{i,t-1})$	0.007	-0.008	0.081*	0.017	0.000	-0.077	81,184.500	7.761**
	(0.447)	(0.799)	(0.092)	(0.648)	(0.999)	(0.698)	(0.107)	(0.030)
$Disposition_{i,t-1}$	-0.031	-0.008	0.091	-0.004	0.044	0.173	-43,563.090	-1.666
	(0.270)	(0.859)	(0.533)	(0.946)	(0.789)	(0.680)	(0.838)	(0.914)
$Return_{i,t-1}$	0.138	0.024	0.044	0.060	0.282	-0.159	-0.017	-0.047
	(0.195)	(0.829)	(0.734)	(0.713)	(0.132)	(0.453)	(0.864)	(0.597)
Constant	0.005	0.627	0.448	-0.053	-0.196	-1.158	1348741.250	104.336
	(0.967)	(0.140)	(0.433)	(0.894)	(0.837)	(0.645)	(0.302)	(0.299)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	166	165	165	65	64	60	153	153
Adjusted R^2	-0.012	0.016	0.043	-0.084	-0.052	-0.100	0.060	0.093

Table AVI. Superstition, Cognitive Limitation, and Intraday Mark-to-market Returns of Limit Orders of Individual Investors

In this table we double sort individual investors into quintiles by the superstition index and the submission ratio at "0" in year *t-1*, and report the intraday mark-to-market return of limit orders in year *t*. Quintile-5 (Q5) investors are more superstitious or have higher submission ratios at round number prices. In each year, we calculate the superstition index for each investor as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" and "0" are calculated in a similar fashion. Mark-to-market intraday return is expressed in percentage, and is the difference between the trade price and the daily closing price divided by the trade price. All items are first calculated for each investor-year observation and then averaged for each quintile with equal weights. To ensure a reasonable magnitude of superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. The Satterthwaite p-value assumes unequal variances of investor performance in quintiles 1 and 5. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Quintile Ranks of $SubRatio_{0,t-1}$	Quintile Ranks of SI_{t-1}						
	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
Q1	-0.057	-0.058	-0.059	-0.074	-0.088	-0.032***	0.000
Q2	-0.077	-0.069	-0.070	-0.075	-0.092	-0.014***	0.003
Q3	-0.082	-0.074	-0.090	-0.079	-0.098	-0.015***	0.004
Q4	-0.092	-0.100	-0.095	-0.096	-0.103	-0.012*	0.051
Q5	-0.102	-0.109	-0.110	-0.106	-0.102	-0.000	0.990
Diff (Q5-Q1)	-0.045***	-0.050***	-0.051***	-0.032***	-0.014*		
p-value	0.000	0.000	0.000	0.000	0.051		

Table AVII. Individual Investors' Superstition Index and Investment Performance – Two-Stage Regression

In this table, we report the parameter estimates of a two-stage panel regression for individual investors. In the first stage, we perform the following regression for each of the eight return measures separately:

$$SI_{i,t-1} = \alpha + \beta_1 OrderSize_{i,t-1} + \beta_2 SubRatio_{0\ and\ 5,i,t-1} + \beta_3 Ln(N_{i,t-1}) + \beta_4\ Disposition_{i,t-1} + \beta_5 Return_{i,t-1} + \varepsilon_{i,t-1}$$

We take $Residual\_SI_{i,t-1}$, the residual superstition index, from the first stage regression and perform the following regression in the second stage:

$$Return_{i,t} = \alpha + \beta_1 Residual\_SI_{i,t-1} + \beta_2 OrderSize_{i,t-1} + \beta_3 SubRatio_{0\ and\ 5,i,t-1} + \beta_4 Ln(N_{i,t-1}) + \beta_5\ Disposition_{i,t-1} + \beta_6 Return_{i,t-1} + \varepsilon_{i,t}$$

where $Return_{i,t}$ and $Return_{i,t-1}$ are the average mark-to-market returns or round-trip performance for investor *i* in year *t* and year *t-1*. $SI_{i,t-1}$ is investor *i*'s superstition index in year *t-1*, which is calculated as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" is calculated in a similar fashion. $OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year *t-1*. $SubRatio_{0\ and\ 5,i,t-1}$ is the sum of investor *i*'s submission ratios at prices ending with "0" and "5" in year *t-1*. $Ln(N_{i,t-1})$ is the log of number of limit orders submitted by investor *i* in the previous year. $Disposition_{i,t-1}$ is the difference between the durations of losing and winning round-trip trades of investor *i* in year *t-1*, divided by their average. Mark-to-market return of limit (market) orders is the return under the assumption that the initiating limit (market) orders are covered at the closing price of a trading day. The round-trip daily profit and daily index return are calculated as the average round-trip profit or index return divided by the average round-trip duration for each investor. Results for the first and second stage regressions are separately reported in Panel A and Panel B. Standard errors are adjusted for heteroskedasticity. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Panel A (First Stage Regression): Regressing Superstition Index on Other Aspects of Investor Trading Skills

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$OrderSize_{i,t-1}$	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.040***	-0.040***	-0.039***	-0.034***	-0.034***	-0.034***	-0.039***	-0.039***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Ln(N_{i,t-1})$	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Disposition_{i,t-1}$	0.005***	0.005***	0.006***	0.006***	0.006***	0.006***	0.005***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Return_{i,t-1}$	-0.010***	-0.002***	0.001	-0.000	-0.000	0.000	-0.000**	-0.000**
	(0.000)	(0.008)	(0.158)	(0.748)	(0.709)	(0.144)	(0.031)	(0.026)
Constant	0.069***	0.070***	0.071***	0.065***	0.065***	0.065***	0.070***	0.070***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	57,217	57,215	57,189	33,585	33,545	32,942	57,263	57,263
Adjusted R^2	0.017	0.017	0.017	0.015	0.015	0.015	0.016	0.016

Panel B (Second Stage Regression): Regressing Investment Performance on Residual Superstition Index

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$Residual\_SI_{i,t-1}$	-0.068***	-0.103***	-0.269***	-0.046	-0.176**	-0.206	-15,849.138	-1.270
	(0.000)	(0.001)	(0.000)	(0.232)	(0.026)	(0.195)	(0.145)	(0.147)
$OrderSize_{i,t-1}$	0.002***	0.001	-0.001	0.002	0.002	-0.001	-1,650.379	-0.114
	(0.007)	(0.565)	(0.518)	(0.124)	(0.331)	(0.774)	(0.187)	(0.241)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.038***	-0.077***	-0.162***	-0.047***	-0.107***	-0.133***	37,803.789	3.085
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.010)	(0.328)	(0.325)
$Ln(N_{i,t-1})$	0.010***	0.013***	0.007*	0.012***	0.017***	0.011	3,592.455	0.293
	(0.000)	(0.000)	(0.080)	(0.000)	(0.000)	(0.270)	(0.295)	(0.288)
$Disposition_{i,t-1}$	-0.024***	-0.034***	-0.023***	-0.023***	-0.040***	-0.040**	16,403.018	1.335
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.026)	(0.268)	(0.267)
$Return_{i,t-1}$	0.071***	0.032***	0.025***	0.011	0.002	0.013	0.632***	0.640***
	(0.000)	(0.000)	(0.000)	(0.254)	(0.864)	(0.205)	(0.000)	(0.001)
Constant	-0.049***	-0.084***	-0.046*	-0.048***	-0.058*	-0.066	-3,393.385	-0.327
	(0.000)	(0.000)	(0.078)	(0.001)	(0.059)	(0.287)	(0.461)	(0.358)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	56,968	56,963	56,824	25,723	25,673	24,962	56,830	56,830
Adjusted R^2	0.029	0.010	0.014	0.006	0.005	0.003	0.000	0.000

Table AVIII. A Placebo Test: Pseudo Superstition Index and Investment Performance of Individual Investors– Regression Analysis

In this table we report the parameter estimates for the following panel regression:

$$Return_{i,t} = \alpha + \beta_1 SI_{i,t-1} + \beta_2 OrderSize_{i,t-1} + \beta_3 SubRatio_{0\ and\ 5,i,t-1} + \beta_4 Ln(N_{i,t-1}) + \beta_5\ Disposition_{i,t-1} + \beta_6 Return_{i,t-1} + \varepsilon_{i,t}$$

where $Return_{i,t}$ and $Return_{i,t-1}$ are the average mark-to-market returns or round-trip performance for investor *i* in year *t* and year *t-1*. $SI_{i,t-1}$ is investor *i*'s pseudo superstition index in year *t-1*, calculated as the difference between limit order submission ratios at "7" and "3." In each year, we calculate the investor's submission ratio at "7" as the number of limit orders submitted at prices ending with "7" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "3" is calculated in a similar fashion. $OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year *t-1*. $SubRatio_{0\ and\ 5,i,t-1}$ is the sum of investor *i*'s submission ratios at prices ending with "0" and "5" in year *t-1*. $Ln(N_{i,t-1})$ is the log of number of limit orders submitted by investor *i* in the previous year. $Disposition_{i,t-1}$ is the difference between the durations of losing and winning round-trip trades of investor *i* in year *t-1*, divided by their average. Mark-to-market return of limit (market) orders is the return under the assumption that the initiating limit (market) orders are covered at the closing price of a trading day. The round-trip daily profit and daily index return are calculated as the average round-trip profit or index return divided by the average round-trip duration for each investor. Standard errors are adjusted for heteroskedasticity. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$SI_{i,t-1}$	-0.015	0.034	0.176	-0.060	0.113	0.067	4,739.201	0.237
	(0.580)	(0.542)	(0.130)	(0.397)	(0.413)	(0.819)	(0.258)	(0.478)
$OrderSize_{i,t-1}$	0.002***	-0.001	-0.004**	0.002	0.003	-0.003	-1,029.776	-0.055
	(0.000)	(0.521)	(0.039)	(0.174)	(0.149)	(0.591)	(0.123)	(0.231)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.039***	-0.083***	-0.163***	-0.044***	-0.118***	-0.204***	-752.143	-0.066
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.433)	(0.358)
$Ln(N_{i,t-1})$	0.011***	0.017***	0.017***	0.011***	0.022***	0.025**	966.223**	0.078***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.021)	(0.016)	(0.008)
$Disposition_{i,t-1}$	-0.019***	-0.048***	-0.139***	-0.019***	-0.058***	-0.145***	-4,654.303***	-0.384***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Return_{i,t-1}$	0.091***	0.027***	0.026***	0.019*	0.007	0.008	0.550***	0.540***
	(0.000)	(0.002)	(0.001)	(0.092)	(0.527)	(0.483)	(0.002)	(0.004)
Constant	-0.061***	-0.097***	-0.045	-0.047***	-0.073**	-0.074	-638.298	-0.103
	(0.000)	(0.000)	(0.105)	(0.004)	(0.036)	(0.286)	(0.774)	(0.485)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	46,741	46,737	46,648	21,323	21,280	20,685	46,815	46,815
Adjusted R^2	0.032	0.014	0.024	0.005	0.006	0.006	0.084	0.089

Table AIX. Individual Investors' Superstition Index and Investment Performance – Lucky vs. Unlucky Side

In this table we report the parameter estimates for the following panel regression:

$$Return_{i,t} = \alpha + \beta_1 SI_{i,t-1} + \beta_2 OrderSize_{i,t-1} + \beta_3 SubRatio_{0\ and\ 5,i,t-1} + \beta_4 Ln(N_{i,t-1}) + \beta_5\ Disposition_{i,t-1} + \beta_6 Return_{i,t-1} + \varepsilon_{i,t}$$

where $Return_{i,t}$ and $Return_{i,t-1}$ are the average mark-to-market returns or round-trip performance for investor *i* in year *t* and year *t-1*. $SI_{i,t-1}$ is the lucky or unlucky part of investor *i*'s superstition index in year *t-1*. In Panel A, we consider the lucky part of superstition index by calculating $SI_{i,t-1}$ as the difference between limit order submission ratios at "8" and "3" for investor *i* in year *t-1*. In Panel B, we consider the unlucky part of superstition index by calculating $SI_{i,t-1}$ as the difference between limit order submission ratios at "3" and "4" for investor *i* in year *t-1*. The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratios at "3" and"4" are calculated in a similar fashion. $OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year *t-1*. $SubRatio_{0\ and\ 5,i,t-1}$ is the sum of investor *i*'s submission ratios at prices ending with "0" and "5" in year *t-1*. $Ln(N_{i,t-1})$ is the log of number of limit orders submitted by investor *i* in the previous year. $Disposition_{i,t-1}$ is the difference between the durations of losing and winning round-trip trades of investor *i* in year *t-1*, divided by their average. Mark-to-market return of limit (market) orders is the return under the assumption that the initiating limit (market) orders are covered at the closing price of a trading day. The round-trip daily profit and daily index return are calculated as the average round-trip profit or index return divided by the average round-trip duration for each investor. Standard errors are adjusted for heteroskedasticity. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Panel A: Lucky Part of the Superstition Index

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$SubRatio_{8,i,t-1}$								
$- SubRatio_{3,i,t-1}$	-0.063***	-0.061*	-0.180**	-0.040	-0.092	-0.272	-39,311.340	-3.264
	(0.000)	(0.075)	(0.011)	(0.356)	(0.293)	(0.139)	(0.306)	(0.293)
$OrderSize_{i,t-1}$	0.002***	0.001	-0.001	0.001	0.002	-0.003	-1,643.621	-0.114
	(0.000)	(0.539)	(0.557)	(0.249)	(0.445)	(0.555)	(0.205)	(0.258)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.046***	-0.083***	-0.172***	-0.049***	-0.127***	-0.178***	48,620.242	3.956
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.326)	(0.324)
$Ln(N_{i,t-1})$	0.011***	0.015***	0.011**	0.013***	0.019***	0.017	2,999.263	0.246
	(0.000)	(0.000)	(0.013)	(0.000)	(0.000)	(0.108)	(0.286)	(0.276)
$Disposition_{i,t-1}$	-0.023***	-0.033***	-0.028***	-0.024***	-0.042***	-0.038**	18,960.959	1.539
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.048)	(0.268)	(0.268)
$Return_{i,t-1}$	0.082***	0.031***	0.028***	0.015	0.002	0.011	0.660***	0.667***
	(0.000)	(0.000)	(0.000)	(0.146)	(0.883)	(0.308)	(0.000)	(0.001)
Constant	-0.052***	-0.091***	-0.054*	-0.047***	-0.053	-0.070	-1,638.501	-0.186
	(0.000)	(0.000)	(0.053)	(0.002)	(0.105)	(0.294)	(0.580)	(0.385)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	51,836	51,832	51,709	23,349	23,303	22,646	51,756	51,756
Adjusted R^2	0.030	0.010	0.014	0.006	0.004	0.003	0.000	0.000

Panel B: Unlucky Part of the Superstition Index

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$SubRatio_{3,i,t-1}$								
$- SubRatio_{4,i,t-1}$	-0.013	-0.084*	-0.248**	-0.024	-0.033	-0.034	-5,608.824	-0.374
	(0.562)	(0.075)	(0.014)	(0.684)	(0.802)	(0.900)	(0.136)	(0.151)
$OrderSize_{i,t-1}$	0.002***	-0.000	-0.003	0.002	0.003	-0.002	-883.853	-0.046
	(0.000)	(0.792)	(0.107)	(0.128)	(0.166)	(0.709)	(0.183)	(0.314)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.040***	-0.078***	-0.160***	-0.047***	-0.119***	-0.150***	-528.127	-0.054
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.008)	(0.559)	(0.410)
$Ln(N_{i,t-1})$	0.011***	0.015***	0.017***	0.011***	0.019***	0.018*	831.421**	0.068**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.078)	(0.023)	(0.011)
$Disposition_{i,t-1}$	-0.020***	-0.047***	-0.136***	-0.018***	-0.054***	-0.147***	-4,539.066***	-0.375***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Return_{i,t-1}$	0.081***	0.025***	0.020***	0.017*	0.005	0.010	0.531***	0.522***
	(0.000)	(0.001)	(0.004)	(0.083)	(0.673)	(0.364)	(0.001)	(0.004)
Constant	-0.056***	-0.088***	-0.048*	-0.043***	-0.057*	-0.065	-212.111	-0.062
	(0.000)	(0.000)	(0.073)	(0.005)	(0.087)	(0.330)	(0.918)	(0.652)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	50,763	50,759	50,657	23,177	23,132	22,489	50,843	50,843
Adjusted R^2	0.031	0.014	0.023	0.005	0.006	0.006	0.081	0.085

Table AX. Individual Investors' Pseudo-Superstition Index, Market Return, and the Buy Ratio and Buy-sell Ratio – Quintile Analysis

In this table we report the Buy Ratio and Buy-sell Ratio for individual investors with various pseudo-superstition indices and under different market returns. We first sort individual investors into quintiles by the pseudo superstition index in one year. Investors in quintile 5 (Q5) of the pseudo-superstitious index are the most pseudo superstitious. We then sort the trading days of the next year into quintiles based on the daily market returns. Market returns on trading days in Quintile-5 (M5) are the highest. We then compute the average Buy Ratio and average Buy-Sell Ratio of each product (MXF or TXF orders that expire in one month, two months, three months, six months, nine months, or one year) for the investors in each pseudo superstitious quintile and market return quintile. We define $SI_{i,t-1}$ as the difference between limit order submission ratios at "7" and "3" for investor *i* in year *t-1*. We calculate the investor's submission ratio at "7" as the number of limit orders submitted at prices ending with "7" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "3" is calculated in a similar fashion. The Buy Ratio is calculated as the number of buy contracts (taking long positions) scaled by total number of executed contracts. We calculate the Buy-sell Ratio as the difference between the numbers of buy and sell contracts, divided by their average. Both limit and market orders are included in the calculation of Buy Ratio and Buy-sell Ratio. Standard errors are adjusted for heteroskedasticity. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. The Satterthwaite p-value assumes unequal variances of investor performance in quintiles 1 and 5. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Panel A: Buy Ratio

Quintile Ranks of	Quintile Ranks of Pseudo $SI_{i,t-1}$						
Market Returns	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
M1	0.705	0.679	0.673	0.668	0.698	-0.007	0.369
M2	0.628	0.613	0.616	0.608	0.626	-0.002	0.261
M3	0.587	0.578	0.579	0.573	0.579	-0.008	0.352
M4	0.552	0.553	0.553	0.548	0.546	-0.007	0.256
M5	0.529	0.537	0.544	0.535	0.526	-0.003	0.165
Diff (M5-M1)	-0.176***	-0.142***	-0.129***	-0.133***	-0.172***		
p-value	0.000	0.000	0.000	0.000	0.000		

Panel B: Buy-Sell Ratio

Quintile Ranks of Market Returns	Quintile Ranks of Pseudo $SI_{i,t-1}$						
	Q1	Q2	Q3	Q4	Q5	Diff (Q5-Q1)	p-value
M1	0.820	0.717	0.691	0.670	0.792	-0.028	0.103
M2	0.513	0.452	0.463	0.430	0.504	-0.009	0.261
M3	0.347	0.312	0.318	0.292	0.315	-0.033	0.105
M4	0.209	0.212	0.214	0.193	0.182	-0.027	0.101
M5	0.117	0.149	0.176	0.138	0.106	-0.012	0.165
Diff (M5-M1)	-0.702***	-0.568***	-0.515***	-0.532***	-0.686***		
p-value	0.000	0.000	0.000	0.000	0.000		

o-Table AXI. Individual Investors' Time-to-Execution/Time-to-Cancellation and Investment Performance

In this table we report the parameter estimates for the following panel regression:

$$Return_{i,t} = \alpha + \beta_1 TimeToExecution_{i,t}(or\ TimeToCancellation_{i,t}) + \beta_2 OrderSize_{i,t-1} + \beta_3 SubRatio_{0\ and\ 5,i,t-1} + \beta_4 Ln(N_{i,t-1}) + \beta_5\ Disposition_{i,t-1} + \beta_6 Return_{i,t-1} + \varepsilon_{i,t}$$

where $Return_{i,t}$ and $Return_{i,t-1}$ are the average mark-to-market returns or round-trip performance for investor *i* in year *t* and year *t-1*. $TimeToExecution_{i,t}$ is the interval from order submission to execution for executed limit orders for investor *i* in year *t*. $TimeToCancellation_{i,t}$ is the interval from submission to cancellation for orders that are submitted and then deleted by investor *i* in year *t*. $OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year *t-1*. $SubRatio_{0\ and\ 5,i,t-1}$ is the sum of investor *i*'s submission ratios at prices ending with "0" and "5" in year *t-1*. $Ln(N_{i,t-1})$ is the log of number of limit orders submitted by investor *i* in the previous year. $Disposition_{i,t-1}$ is the difference between the durations of losing and winning round-trip trades of investor *i* in year *t-1*, divided by their average. Mark-to-market return of limit (market) orders is the return under the assumption that the initiating limit (market) orders are covered at the closing price of a trading day. The round-trip daily profit and daily index return are calculated as the average round-trip profit or index return divided by the average round-trip duration for each investor. Standard errors are adjusted for heteroskedasticity. To ensure a reasonable magnitude of the superstition index, we require that investors submit at least 10 limit orders in each of two consecutive years. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Panel A. Time-to-Execution

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$TimeToExecution_{i,t}$	-0.029***	-0.038***	-0.043***	-0.019***	-0.021**	-0.006	-17,251.539	-1.390
	(0.000)	(0.000)	(0.000)	(0.000)	(0.015)	(0.716)	(0.307)	(0.310)
$OrderSize_{i,t-1}$	0.001**	0.000	-0.002	0.002	0.002	-0.001	-1,711.001	-0.119
	(0.011)	(0.665)	(0.477)	(0.125)	(0.338)	(0.790)	(0.190)	(0.244)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.020***	-0.052***	-0.134***	-0.033***	-0.092***	-0.125**	48,778.242	3.970
	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)	(0.018)	(0.324)	(0.322)
$Ln(N_{i,t-1})$	0.010***	0.013***	0.007*	0.012***	0.017***	0.010	3,507.781	0.286
	(0.000)	(0.000)	(0.086)	(0.000)	(0.001)	(0.286)	(0.296)	(0.289)
$Disposition_{i,-1}$	-0.021***	-0.030***	-0.018**	-0.021***	-0.038***	-0.040**	18,288.088	1.487
	(0.000)	(0.000)	(0.012)	(0.000)	(0.000)	(0.027)	(0.272)	(0.272)
$Return_{i,t-1}$	0.064***	0.030***	0.025***	0.010	0.002	0.012	0.636***	0.644***
	(0.000)	(0.000)	(0.000)	(0.258)	(0.860)	(0.210)	(0.000)	(0.001)
Constant	-0.045***	-0.078***	-0.039	-0.044***	-0.053*	-0.065	-124.241	-0.064
	(0.000)	(0.000)	(0.136)	(0.002)	(0.082)	(0.293)	(0.957)	(0.686)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	56,952	56,947	56,808	25,735	25,685	24,974	56,843	56,843
Adjusted R^2	0.034	0.012	0.015	0.007	0.005	0.003	0.000	0.000

Panel B. Time-to-Cancellation

Independent	Mark-to-market Return of Limit Orders (%)			Mark-to-market Return of Market Orders (%)			Round-trip Performance	
Variable	Intraday	1-day	5-day	Intraday	1-day	5-day	Daily profit (TWD)	Daily index return (%)
$TimeToCancellation_{i,t}$	-0.008***	-0.011***	-0.011***	-0.006***	-0.013***	-0.024***	38.063	0.006
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.847)	(0.706)
$OrderSize_{i,t-1}$	0.001**	0.000	-0.001	0.002*	0.002	-0.001	-772.719	-0.039
	(0.017)	(0.718)	(0.523)	(0.079)	(0.304)	(0.837)	(0.287)	(0.445)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.032***	-0.066***	-0.148***	-0.037***	-0.082***	-0.079	-1,430.179	-0.095
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.139)	(0.168)	(0.203)
$Ln(N_{i,t-1})$	0.009***	0.011***	0.004	0.010***	0.013***	0.004	161.475	0.016
	(0.000)	(0.000)	(0.358)	(0.000)	(0.007)	(0.644)	(0.683)	(0.611)
$Disposition_{i,t-1}$	-0.022***	-0.031***	-0.020***	-0.020***	-0.034***	-0.030*	1,363.819*	0.118*
	(0.000)	(0.000)	(0.008)	(0.000)	(0.000)	(0.097)	(0.068)	(0.078)
$Return_{i,t-1}$	0.066***	0.029***	0.023***	0.009	0.001	0.009	0.562***	0.575***
	(0.000)	(0.000)	(0.000)	(0.315)	(0.957)	(0.373)	(0.001)	(0.003)
Constant	-0.036***	-0.062***	-0.019	-0.031**	-0.028	-0.022	1,322.681	0.041
	(0.000)	(0.000)	(0.485)	(0.033)	(0.371)	(0.733)	(0.526)	(0.771)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	55,372	55,367	55,234	25,271	25,223	24,521	55,312	55,312
Adjusted R^2	0.032	0.011	0.014	0.006	0.004	0.003	0.071	0.078

Appendix Table AXII. Investors' Learning and Superstition

In this table we report the parameter estimates from the following regression for individual investors:

$$SI_{i,t} - SI_{i,t-1} = \alpha + \beta_1 Ln(N_{i,t-k}) + \beta_2 Return_{8,i,t-1} + \beta_3 Return_{4,i,t-1} + \beta_4 Return_{other,i,t-1} + \beta_5 Return_{market,i,t-1} + \beta_6 SI_{i,t-1} + \beta_7 OrderSize_{i,t-1} + \beta_8 SubRatio_{0\ and\ 5,i,t-1} + \beta_9 Disposition_{i,t-1} + \varepsilon_{i,t}$$

where $SI_{i,t}$ and $SI_{i,t-1}$ are the superstition indices for investor *i* in years *t* and *t-1*, and are calculated as the difference between limit order submission ratios at "8" and "4" in each year. We calculate the investor's submission ratio at "8" as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" is calculated in a similar fashion. $Ln(N_{i,t-k})$ is the log of the number of limit orders submitted by investor *i* in year *t-k* (*k* is an integer that ranges from 1 to 3). $Return_{8,i,t-1}$ is the mark-to-market intraday return of limit orders submitted by investor *i* at prices ending with "8" in year *t-1*. $Return_{4,i,t-1}$ is the mark-to-market intraday return of limit orders submitted by investor *i* at prices ending with "4" in year *t-1*. $Return_{others,i,t-1}$ is the mark-to-market intraday return of limit orders submitted by investor *i* at prices ending with other numbers in year *t-1*. $Return_{market,i,t-1}$ is the mark-to-market intraday return of market orders submitted by investor *i* in year *t-1*. $OrderSize_{i,t-1}$ is the average number of contracts per limit order submitted by investor *i* in year *t-1*. $SubRatio_{0\ and\ 5,i,t-1}$ is the sum of investor *i*'s submission ratios at prices ending with "0" and "5" in year *t-1*. $Disposition_{i,t-1}$ is the disposition effect, which is calculated as the difference between the durations of losing and winning round-trip trades of investor *i* in year *t-1*, divided by their average. We express the superstition index in percentage. In models 1 and 4, we require that investors submit at least 10 limit orders in each of the two consecutive years. Standard errors are adjusted for heteroskedasticity. In models 2 and 5, we require that investors must submit at least 10 limit orders in each of three consecutive years. In models 3 and 6, we require that investors submit at least 10 limit orders in each of four consecutive years. *, **, and *** indicate significance levels of 0.1, 0.05, and 0.01, respectively.

Independent Variables	$SI_{i,t} - SI_{i,t-1}$ (%)					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
$Ln(N_{i,t-1})$	-0.096***			-0.188***		
	(0.000)			(0.000)		
$Ln(N_{i,t-2})$		-0.075***			-0.093***	
		(0.003)			(0.009)	
$Ln(N_{i,t-3})$			0.001			-0.082
			(0.976)			(0.127)
$Return_{8,i,t-1}$ (%)				-0.103	-0.111	-0.133
				(0.343)	(0.306)	(0.478)
$Return_{4,i,t-1}$ (%)				-0.052	-0.055	-0.002
				(0.602)	(0.577)	(0.989)
$Return_{other,i,t-1}$ (%)				-0.767**	-0.858***	-0.692
				(0.018)	(0.008)	(0.185)
$Return_{market,i,t-1}$ (%)				0.032	0.020	0.075
				(0.772)	(0.856)	(0.683)
$SI_{i,t-1}$ (%)	-0.434***	-0.434***	-0.391***	-0.333***	-0.333***	-0.270***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$OrderSize_{i,t-1}$	-0.047***	-0.049***	-0.035**	-0.013	-0.019	-0.023
	(0.000)	(0.000)	(0.031)	(0.293)	(0.125)	(0.173)
$SubRatio_{0\ and\ 5,i,t-1}$	-0.932***	-0.884***	-1.512***	-0.017	0.044	-0.832**
	(0.000)	(0.000)	(0.000)	(0.940)	(0.844)	(0.011)
$Disposition_{i,t-1}$	0.279***	0.276***	0.340***	0.207***	0.196***	0.204*
	(0.000)	(0.000)	(0.000)	(0.003)	(0.005)	(0.060)
Constant	2.785***	2.634***	2.392***	2.274***	1.677***	2.050***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	56,260	56,260	24,388	22,298	22,298	9,404
r2_a	0.168	0.168	0.153	0.090	0.089	0.069

Figure A1. Limit Order Submission Ratios on Various Days of the Month

In this figure, we report the proportion of limit orders submitted by investors on various dates in the month. The submission ratio is calculated as the number of limit orders submitted on each date of the month divided by the total number of limit orders submitted in the month. We report the figures separately for individual investors, domestic institutions, and Qualified Foreign Institutional Investors (QFIIs.)

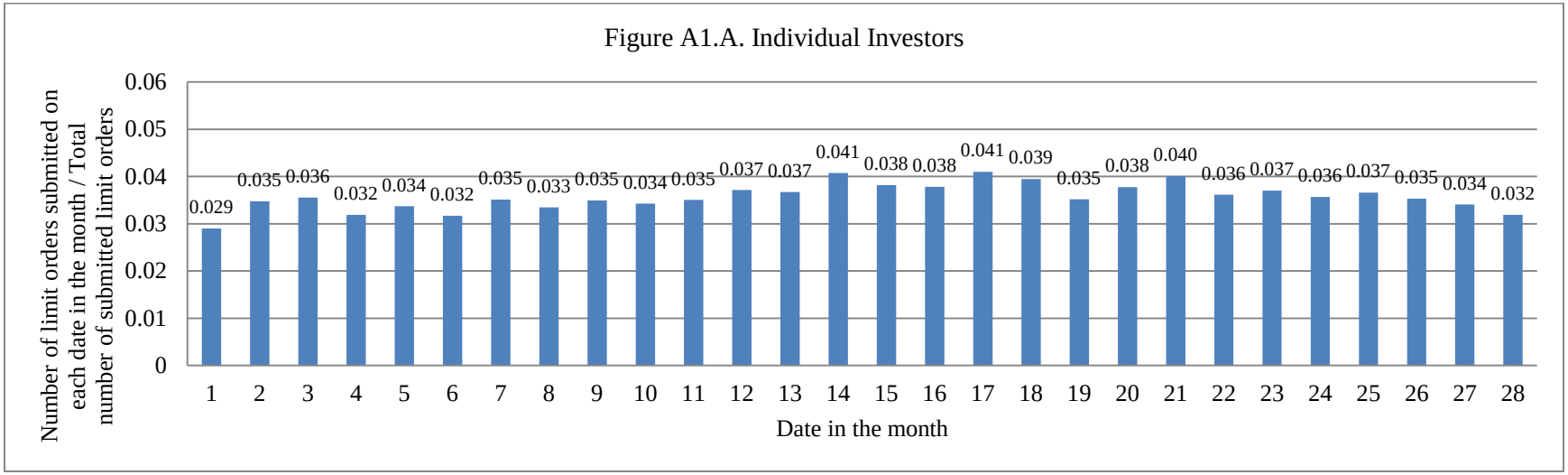


Figure A1.B. Domestic Institutions

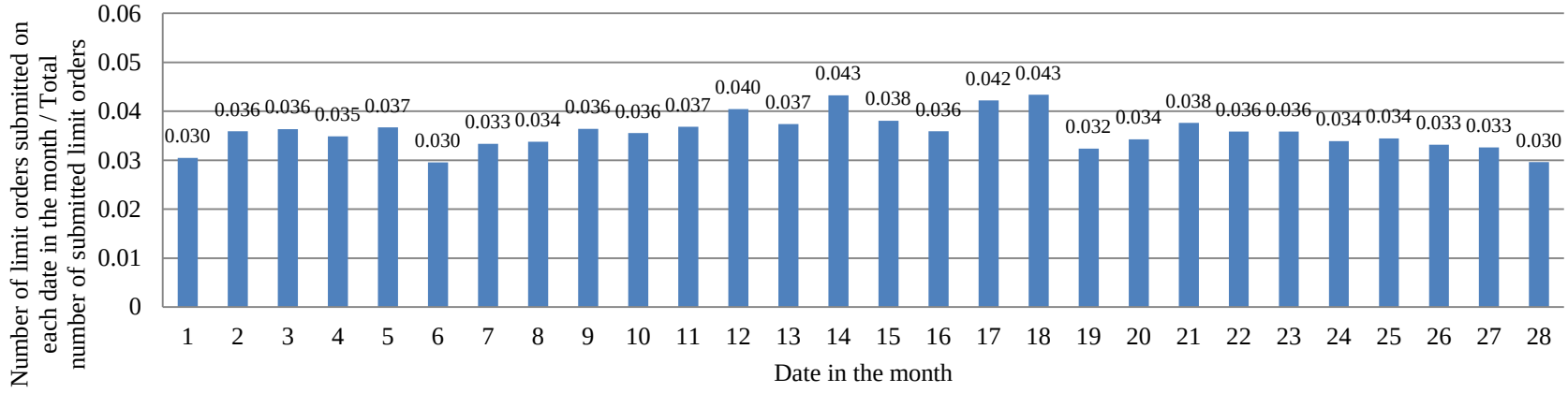


Figure A1.C. Qualified Foreign Institutional Investors

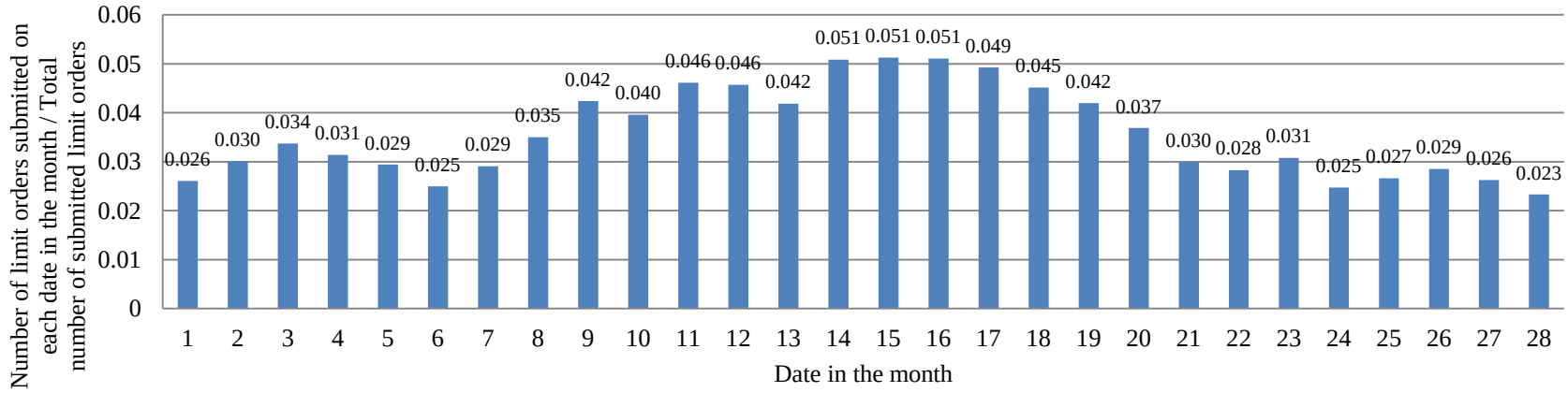


Figure A2. Limit Order Submission Ratios at Various Prices for Limit Buy Orders

In this figure, we report the proportion of limit buy orders submitted by investors at prices ending with "X" (X is an integer ranging from 0 to 9). The submission ratio is calculated as the number of limit buy orders submitted at "X" divided by the total number of submitted limit buy orders. We report the figures separately for individual investors, domestic institutions, and Qualified Foreign Institutional Investors (QFIIs.)

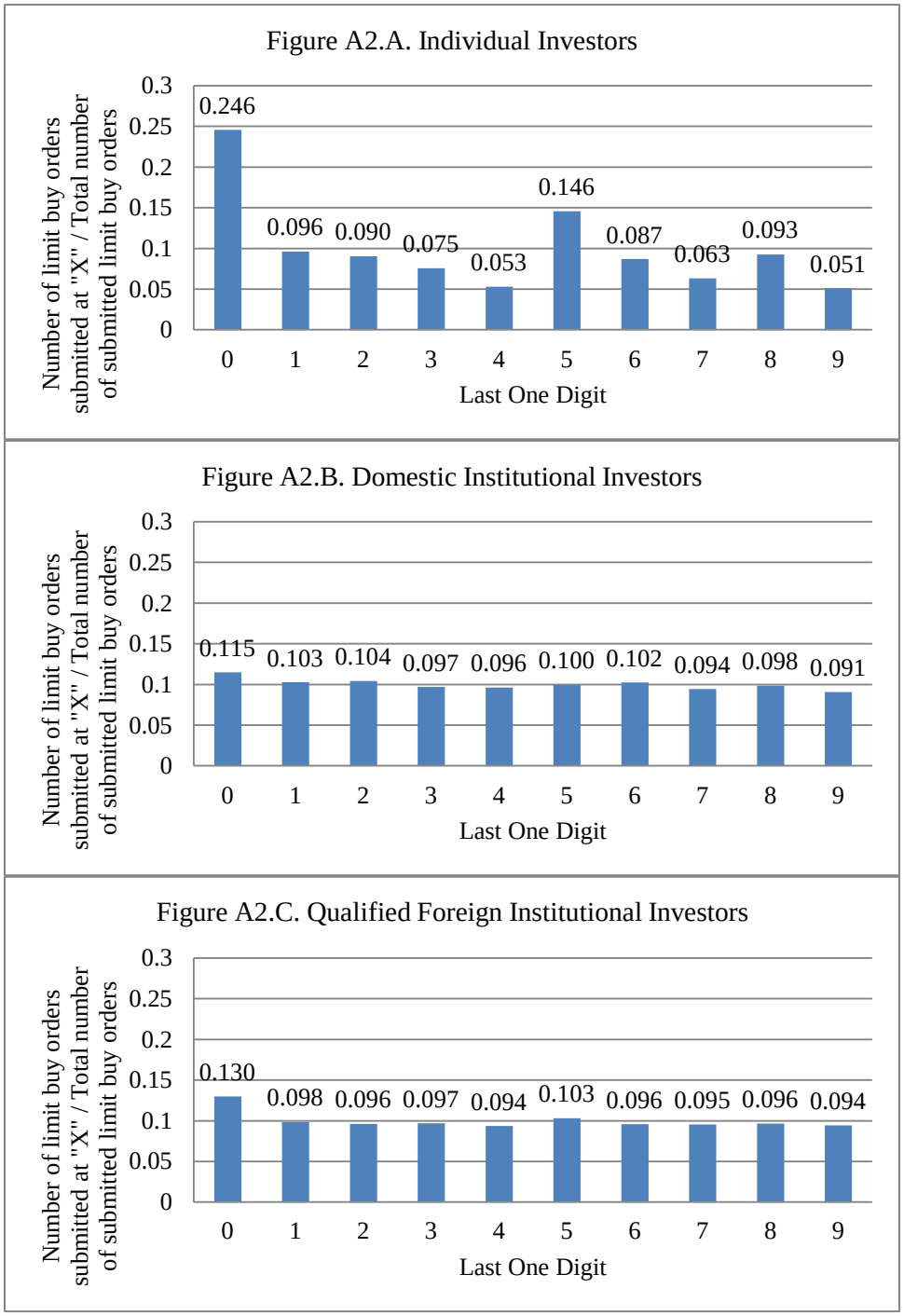


Figure A3. Limit Order Submission Ratios at Various Prices for Limit Sell Orders

In this figure, we report the proportion of limit sell orders submitted by investors at prices ending with "X" (X is an integer ranging from 0 to 9). The submission ratio is calculated as the number of limit sell orders submitted at "X" divided by the total number of submitted limit sell orders. We report the figures separately for individual investors, domestic institutions, and Qualified Foreign Institutional Investors (QFIIs.)

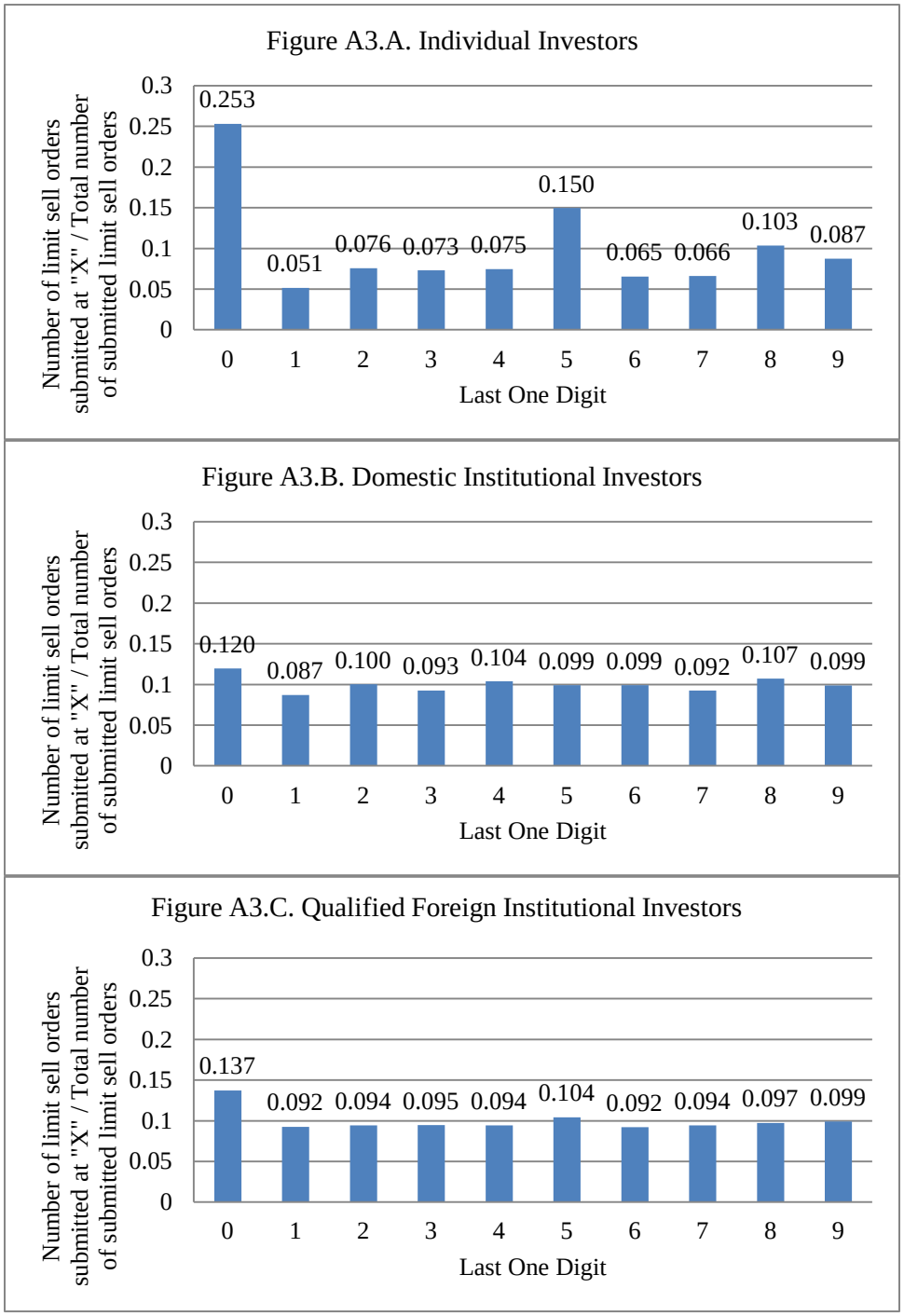
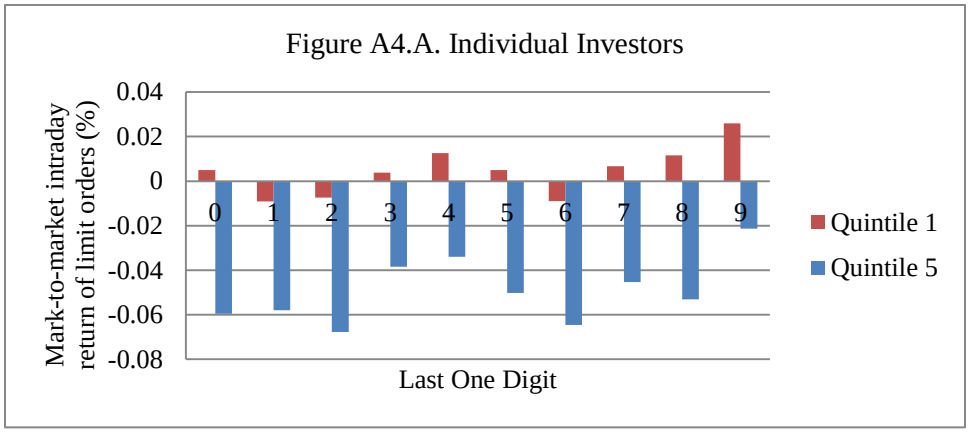
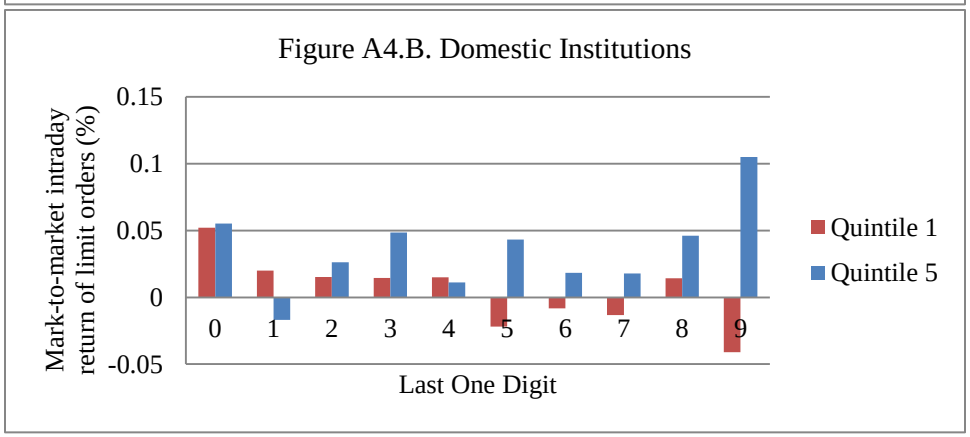


Figure A4. Superstition and Intraday Returns of Limit Orders Submitted at "X"

In this figure, we sort investors into quintiles by the superstition index in one year, and plot the mark-to-market return of limit orders submitted at prices ending with "X" in the subsequent year (X is an integer ranging from 0 to 9). Quintile-5 (Q5) investors are more superstitious. In each year, we calculate the superstition index for each investor as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" is calculated in a similar fashion. Mark-to-market intraday return is the difference between the trade price and the daily closing price divided by the trade price. Results for individual investors, domestic institutions, and Qualified Foreign Institutional Investors (QFIIs) are reported separately.





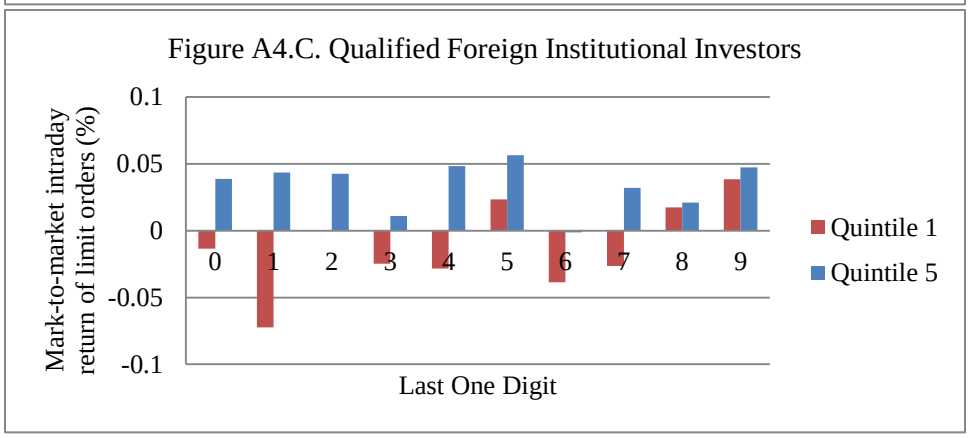


Figure A5. Intraday Returns of Institutional Investors When They Pick Up Limit Orders Submitted by Individual Investors at "X"

In this figure, we plot the returns of institutional investors when they pick up the limit orders submitted by individual investors. We first sort individual investors into quintiles by the superstition index in one year, and group their limit orders in the subsequent year into ten groups according to the last digit of limit order prices. The Quintile-5 individual investors are the most superstitious. We then identify the individual limit orders that are picked up by institutional investors. The intraday mark-to-market returns of institutional investors are calculated separately for those orders that have picked up the limit orders submitted by the Quintile-5 and Quintile-1 individual investors, and for each of the last one digit. In each year, we calculate the superstition index for each investor as the difference between limit order submission ratios at "8" and "4." The submission ratio at "8" of an investor is calculated as the number of limit orders submitted at prices ending with "8" divided by the total number of limit orders submitted at all prices within a year. The submission ratio at "4" is calculated in a similar fashion. Mark-to-market intraday return of institutional investors is the difference between the trade price and the daily closing price divided by the trade price. Results for domestic institutions and Qualified Foreign Institutional Investors (QFIIs) are shown in figures A5.A and A5.B, respectively.